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THE OHIO JOURNAL OF SCIENCE

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THE PRODUCTION OF OSTEOMYELITIS IN RATS[1]

J. EMERSON KEMPF AND J. ARTHUR HERRICK,
From the Hygienic Laboratory, University of Michigan,
Ann Arbor

Rodet (1) in 1884 was the first to produce, by the intravenous injection of staphylococci into young rabbits, the suppurative necrotic lesions of bone resembling those of hematogenous osteomyelitis in man. Since then, other workers have employed rabbits, with considerable success, for studies of this disease. The dog has also been used, (2, 3, 4), but the results have been somewhat less satisfactory. Since small laboratory animals offer special advantages for the study of osteomyelitis, it seemed desirable to investigate the production of this disease in a relatively cheap and available animal, the rat.

Several years ago, in this laboratory, Mr. Paul Prager was able to produce experimental osteomyelitis in the tibia of the white rat. His technique was to insert a piece of No. 50 white cotton thread into the bone marrow, and then inject into the area a culture of *Staphylococcus aureus*. This paper deals with further studies and technical modifications of Prager's method.

The organism used in these experiments was a strain of *Staphylococcus aureus* which had been isolated from a patient with chronic hematogenous osteomyelitis. It was maintained on blood agar slants and stored between growth periods for as long as 6 months without losing infectivity. All cultures used as inoculums were prepared by transferring organisms from a blood agar slant to 0.1% glucose proteose peptone broth (Difco), and incubating at 37 C. for 24 hours.

The rats employed in these experiments were of the Wistar strain. Preparatory to inoculation, the animals were anesthetized by the parenteral injection of nembutal (40 mg. per kg. of body weight). For producing trauma of the bone or local inoculation, the hair on the leg was clipped, the skin swabbed with iodine, and a 1-cm. incision made over the medial aspect of the proximal portion of the tibia. The periosteum was scraped from the tibia, and a hole 1 to 2 mm. in diameter was pierced with a small forceps or scissors through the compact layer into the bone marrow. Following inoculation, the skin was sutured with cotton thread. The skin incisions healed rapidly, as a rule.

A number of variations in procedures used for the production of osteomyelitis were made:

Method 1: Rats were inoculated by injecting 0.1 ml. of culture deep into the marrow cavity.

Method 2: A 2- to 3-cm. length of No. 50 white cotton thread, saturated with the broth culture, was inserted deep into the marrow. This was followed by the injection of 0.1 ml. of culture into the marrow.

Method 3: A wisp of cotton, soaked with the culture, was inserted into the bone with the aid of a small curved forceps. As in method number 2, this was followed by the injection of 0.1 ml. of the inoculum.

[1]A preliminary report of this investigation was presented at the East Lansing meeting of the Michigan Branch of the Society of American Bacteriologists, June 1, 1945.

Method 4: About 0.1 ml. of warm 1.5% agar gel was injected into the marrow cavity. A few minutes were allowed to elapse, after which 0.1 ml. of the culture was injected into the agar mass. Dochez (5) used agar to protect streptococci against the defenses of the horse in inoculations made for the purpose of producing antiserum.

Method 5: One-tenth ml. of a 10% suspension of gastric mucin,[2] sterilized by autoclaving, was injected into the tibial lesion. An injection of 0.1 ml. of the culture was then made.

Method 6: One-tenth ml. of xylene, followed by the same quantity of culture, was injected into the marrow cavity.

Method 7: This was the same as method 6, except that cotton soaked in culture, as described in method 3, was inserted after the injection of the xylene, and before the injection of the culture.

Method 8: One-tenth ml. of the inoculum was injected into one of the tail veins. No local trauma was made.

Method 9: The rats were given an intravenous inoculation of culture as described above. Within 30 minutes, an opening was made into the marrow of the tibia, but no local inoculation of culture was given.

Method 10: The animals received 0.1 ml. of the culture intravenously, as well as 0.1 ml. locally into the marrow cavity of the tibia.

Method 11: Intravenous inoculation of culture was followed by the injection of 0.1 ml. of a 10% solution of sodium morrhuate[3] into the bone marrow.

Method 12: This procedure was similar to Method 11, except that the tibial lesion was treated with xylene prior to being injected with the culture.

Following inoculation, the rats were observed for 3 or 4 weeks, at which time they were anesthetized, the site of inoculation reopened, and observations made as to the presence of subcutaneous abscesses, pus, necrotic bone, and the size of the aperture in the bone. A culture was made from the center of the inoculated area, in 0.1% glucose proteose peptone broth. If growth occurred, the organisms were stained by Gram's method and examined. If the aperture of the bone lesion was 3 mm. or more in diameter, contained pus, and yielded gram-positive cocci on culture, a diagnosis of osteomyelitis was made. To verify this conclusion, sections of affected bones from 14 rats, judged to have osteomyelitis, were sent to the Department of Pathology, where the diagnosis was confirmed by microscopic examination.

The results of attempts to produce osteomyelitis by the various methods outlined above are summarized in Table I. The most successful method appeared to be that of placing a non-absorbable foreign body, such as cotton, saturated with a broth culture of *Staph. aureus*, in the bone marrow. This method produced osteomyelitis in 94% of 81 rats. The use of method number 2, i. e., the insertion of culture-soaked thread into the bone marrow, followed by injection of 0.1 ml. of the culture, produced osteomyelitis in 72% of 60 rats. The addition of an agent, such as xylene, known to inhibit the action of the leukocytes, at least during the first hours following inoculation, did not increase the incidence of bone lesions.

Results following the injection of staphylococci and agar into the bone marrow, in the hope that the agar would interfere with the defenses of the rat, were as satisfactory as those obtained when thread was used as a foreign body. Of thirteen rats so inoculated, 77% developed osteomyelitis. The injection of mucin or xylene along with the bacterial inoculum did not result in any significant increase in the incidence of the disease over that of the group of animals receiving culture

[2]Lot No. 49799, prepared by the Wilson Laboratories, Division of Wilson and Company, Incorporated, Chicago, Illinois.

[3]Lot No. 097-S, Burroughs Wellcome and Company, New York.

alone. Staphylococci injected into the bone marrow, with no foreign body, caused osteomyelitis in only 12.5% of 16 animals so inoculated.

The intravenous injection of staphylococci into rats, with or without trauma to the bone, did not produce the disease.

Since osteomyelitis in man has a tendency to occur more frequently in the young, it seemed advisable to determine the relationship of the age of rats to their susceptibility to experimentally induced osteomyelitis. Rats were divided into two age groups as determined by their weights, the young group averaging 50 grams each and the adult group approximately 250 grams. All were inoculated by method 3. The results are presented in Table II. It will be noted that 85% of fourteen 50-gram animals developed osteomyelitis, while 72% of 14 older rats developed the disease. The difference in incidence of infection is suggestive of a somewhat greater susceptibility of young rats in comparison with older animals.

TABLE I

THE RESULTS OF VARIOUS METHODS FOR THE PRODUCTION OF OSTEOMYELITIS IN THE TIBIA OF THE WHITE RAT

Method Number and Procedure*	Number of Animals	Percentage of Animals which Developed Osteomyelitis
1. *Staph.* culture injected into bone	16	12.5
2. *Staph.* and cotton thread in bone	60	72
3. *Staph.* and cotton wisp in bone	81	94
4. *Staph.* and agar in bone	13	77
5. *Staph.* and mucin in bone	18	11
6. *Staph.* and xylene in bone	16	19
7. *Staph.*, cotton and xylene in bone	20	85
8. *Staph.* intravenously	9	0
9. *Staph.* intravenously and tibial trauma	9	11
10. *Staph.* intravenously and in bone	13	0
11. *Staph.* intravenously and sodium morrhuate in bone	25	20
12. *Staph.* intravenously and xylene in bone	11	27

*The several methods are described in detail in the text.

TABLE II

THE EFFECT OF THE AGE OF RATS ON THEIR SUSCEPTIBILITY TO OSTEOMYELITIS

Average Weight of Animals	Number Inoculated	Percentage which Developed Osteomyelitis
50 grams	14	85
250 grams	14	72

Since the course of osteomyelitis in man is variable, ranging from acute to chronic, the course of the disease in one group of rats was followed for an extended period. Thirty-five rats with osteomyelitis 25 days after inoculation were observed 50 to 65 days longer. Sixty-six per cent of these animals still had gross evidence of the disease, while the remainder had evidence of healed craters in the bone, from which bacteria could not be cultured.

SUMMARY

Several modifications of a method for the production of osteomyelitis in the tibia of the white rat have been evaluated. The insertion into the bone marrow of a cotton wisp impregnated with a broth culture of *Staph. aureus* was found to be the most satisfactory of the various procedures tested. Substitution of a piece of cotton thread or of agar, for the cotton wisp, resulted in a significant though somewhat lower incidence of osteomyelitis. Little success was attained when no foreign body was present. The use of such agents as mucin or xylene did not significantly change the incidence of infection from that obtained when culture alone was injected into the bone.

The susceptibility of young rats appeared to be slightly greater than that of older animals.

The lesions persisted for as long as 75 to 90 days in 66% of 35 animals.

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(1) **Rodet, A.** 1884. Étude expérimentale sur l'ostéomyélite infectieuse. Compt. Rend. Acad. des Sci. 99 : 569–571.
(2) **Starr, C. L.** 1922. Acute hematogenous osteomyelitis. Arch. Surg. 4 : 567–587.
(3) **Bancroft, F. W.** 1921. Acute haematogenous osteomyelitis. Ann. Surg. 73 : 681–700.
(4) **Schemen, L., Lewin, P., Sideman, S.,** and **Janota, M.** 1943. Experimental osteomyelitis. Am. J. Surg. 60 : 371–380.
(5) **Dochez, A. R.** 1925. Etiology of scarlet fever. Medicine 4 : 251–274.

A Book to Enjoy

This volume is the third in a series on mountains for which Professor Roderick Peattie is acting as editor. In this instance he has contributed a foreword telling of his early enjoyment of mountain climbing in southwestern Colorado near the mining camp of Curay. By a lucky turn of fate he met Dr. Atwood on this jaunt. "I learned far more from Wallace Atwood on that trip than I did in his classroom," Peattie says and thus sets the whole atmosphere of the book, namely, to take the reader out into the field in company with a distinguished teacher who can be the serious field worker and have fun camping also. The chapters are alternately camping and geology. Nine of the National Park areas are treated in one chapter. In another, spiced with miner's yarns, a number of the famous Western mining centers are covered. Indians, ranchmen, farmers, tourists, camp trails and saddle horses all enliven the human picture. The stories of volcanoes, of how mountains rise and are worn down, the nature of core rocks and other topics present the vast geological panorama in the remaining chapters. Illustrations are of two sorts. Photographs and numerous handsome pen sketches by Eugene Kingman. This is just the book for a present to an enthusiastic traveler.—*A. E. Waller.*

The Rocky Mountains. Wallace W. Atwood. The Vanguard Press, New York, 1945 pp. 324. $3.75.

THE WILMINGTON REGION

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The Wilmington Region occupies the greater part of Clinton County in southwestern Ohio on the eastern margin of the Little Miami drainage basin (Fig. 1). This region is the area tributary to the town of Wilmington. The region is approximately circular with a radius of some ten miles from its center, the city of Wilmington.

The settlement pattern is irregular, with property lines running in various directions forming many different geometric designs. No north-south or east-west property lines, roads, or village streets occur in the region served by Wilmington. This settlement pattern is characteristic of the entire area between the Scioto and Little Miami Rivers known as the Virginia Military Lands.[1] The failure of Wilmington to square with the cardinal points of the compass is noteworthy since the city was platted on a rectangular pattern as the county seat in August, 1810.

The historical occupancy of the region can be divided into four periods: (1) the early period of settlement from 1804 to the formation of Clinton County in 1810; (2) from the establishment of the county to 1852, when Virginia relinquished all her remaining claims to the Federal Government[2] (3) the opening of remaining lands to all settlers, 1852–1880, a period of greatest growth; and (4) 1880 to the present, a period of decline in population.

The terrain of the Wilmington Region varies from undulating to gently rolling. It lies within the till plains of the Central Lowland.[3] The area was covered by drift during the Illinoian, Early Wisconsin and Late Wisconsin glacial stages.[4] The most conspicuous glacial features are the Cuba Moraine, terminal moraine of the early Wisconsin, and the Reesville Moraine (Fig. 1), terminal moraine of the late Wisconsin, and the erratics. The Illinoian drift was covered by a thin layer of loess. The underlying bed rock is dolomite, limestone and shale of the late Ordovician and early Silurian ages. The Niagara Formation of early Silurian is the only mineral deposit worked in the area.

The streams of the region are small, often irregular in flow. Most of the streams are tributary to the Little Miami River with the divide between the drainage basins of the Little Miami and the Scioto Rivers following the Reesville Moraine through the eastern part of the county.

The original vegetation at the time of settlement consisted of an oak-hickory hardwood forest with oak, hickory, beech and maple predominating.[5]

The soils are gray-brown podzolic and gray planosols.[6] These soils have been formed in a humid, intermediate climate. The podzolic soils are the more fertile and are associated with the Wisconsin drift. The planosols have been formed from the loess deposits and are characterized by the level areas they occupy and the development of impervious hardpan layers at varying depths.

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[1]Peters, W. E., Ohio Lands and Their History, 3rd ed. Athens, 1930, p. 123.
[2]Ibid, p. 134.
[3]Fenneman, N. M., Physiography of Eastern United States. New York, 1938. p. 455.
[4]Austin, G. M., Surface Geology of Clinton County, Ohio. Wilmington, 1930. p. 7.
[5]Watson, S. A., Vegetation of Clinton County at Time of Settlement. Wilmington, 1927. Mimeographed.
[6]U. S. Dept. of Agric.—Yearbook of Agriculture, 1936. Soils and Men, Map—"Soil Associations of the United States."

This region has been classified as humid microthermal with adequate precipitation at all seasons.[7] On the average, January is the coldest month (30.3° F.) and July the warmest (75.8° F.). The yearly mean is 53.0° F., with an average growing season of 153 days. The average annual precipitation over a 28 year period

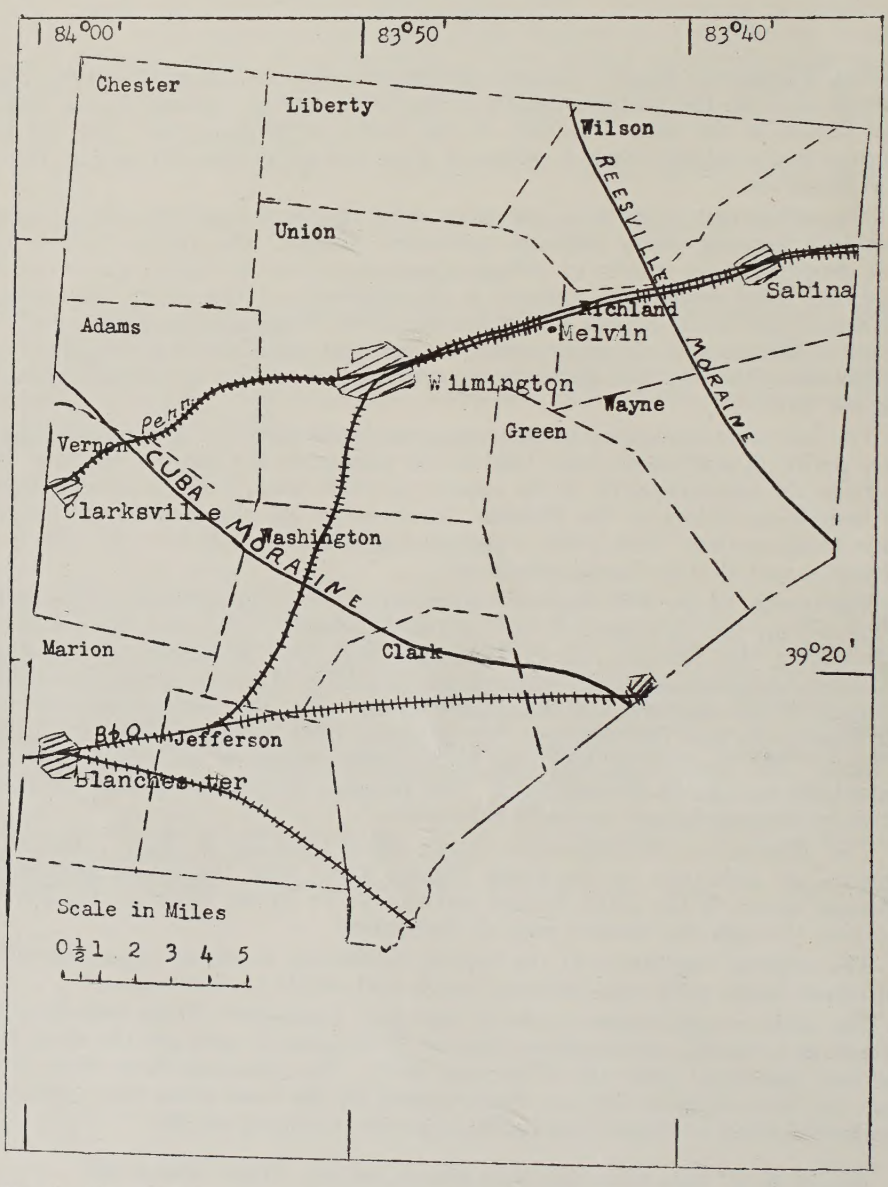

FIG. 1. Map of Clinton County, Ohio. Reesville Moraine—Terminal Moraine of Late Wisconsin Drainage divide between Little Miami and Scioto. Cuba Moraine—Terminal Moraine of Early Wisconsin. Wilmington—County Seat.

[7]Thornthwaite, C. W., "Climates of North America According to a New Classification," Geographical Review, Vol. 21, 1931, p. 633-655; p. 651; Map opposite p. 654.

is 45.9 inches,[8] rather evenly distributed throughout the year, but slightly higher and often irregular in the summer months.

ECONOMIC DEVELOPMENT

The difficulties of transportation in the early days of settlement made it necessary for the settlers to be practically self-sufficient. They raised all of their food and most of the products from which they made their clothing. Such early industry as developed was largely one of converting agricultural surpluses into marketable commodities, or to fill a local need. Flour or grist mills, tanyards and distilleries were established to take care of an agricultural surplus. Brick, harness, shoe, hat, cabinet and wagon making were among the first non-agricultural industries of the community. These products were consumed locally.[9] A corn-hog agricultural economy set in rather early. At first swine were driven to market, but by 1830 local slaughter and packing houses had been erected and shipments of their products were made by wagon to Cincinnati.[10]

The first railroad through Wilmington, the Pennsylvania,[11] was opened for traffic in 1853.[12] This made connections with Cincinnati and Zanesville. In 1883 another railroad, the Baltimore and Ohio,[13] provided connections with Cincinnati and Columbus.[14] These lines provided good facilities for bringing in finished products and shipping local agricultural products of the region to more distant markets.

The greatest change in the period following the building of the railroad came in a shift in the type of manufacturing. Local manufacturing already mentioned gave way to better and more economical products from other regions. However, an industry involving the manufacture of metal products developed in Wilmington. Although this new industry depended on raw materials imported from outside the region and upon a national market for the sale of finished products, it has attained great importance in the local economy.

The earliest highway in Clinton County was Kenton's Trace, known as the Urbana or Ripley Road, which was laid out before 1803.[15] The present system of roads is the outgrowth of various traces, turnpikes, toll roads and after 1848, free roads.[16] These early roads were poor by present standards, mostly rough, narrow, gravel roads, but none-the-less important.

The advent of the automobile changed road building standards here as elsewhere. Today Wilmington is the center of an excellent system of hard surfaced highways radiating throughout the county and providing easy access to all parts of the state. The importance of Wilmington to the county increased with the development of the automobile. The city became physically more accessible and in terms of time was now closer to all parts of the county. The Wimlington Region itself increased in size.

ECONOMY OF THE WILMINGTON REGION

The Wilmington Region is near the heart of a small section of the corn belt in southwestern Ohio called the "Fayette-Champaign Livestock phase of the Corn

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[8]U. S. Weather Bureau, "Climatic Summary of the United States to 1930," Sec. 69. Southwestern Ohio, and Annual Reports, 1931-1943.

[9]History of Clinton County. Beers and Co., 1888, Chicago. p. 482-491.

[10]Ibid, p. 790.

[11]Originally known as The Cincinnati, Wilmington and Zanesville Railroad.

[12]Annual Report of the Commissioner of Railroads and Telegraphs, State of Ohio, Year ending June 30, 1870. p. 622.

[13]Originally known as The Columbus, Cincinnati and Midland Railroad.

[14]Annual Report of the Commissioner of Railroads and Telegraphs, State of Ohio, Year ending June 30, 1884. p. 684.

[15]History of Clinton, op. cit., p. 359.

[16]Ibid., p. 363, 364.

Belt," while the southern limits are included in the "Maysville-West Union General Tobacco-Livestock Self-Sufficiency" province.[17]

Within this farming region there is a minimum of diversity. As one moves from the center towards the periphery few changes are noticeable. The terrain to the south becomes more highly dissected, the soil is less productive and there is less emphasis upon corn. No change is noticed within the region to the north and east where there is a continuation of the livestock phase of the corn belt. This type of agricultural economy extends to the hill section of the Appalachian Plateau near the Scioto River on the east, and northward of a distance of over fifty miles.

Farming methods are more or less uniform. Crop rotation, generally on a three year basis, is the accepted practice. The order of succession is corn, small grain, pasture and return to corn. Corn is first in importance occupying over one-half of the land; wheat is second occupying one-third the acreage devoted to corn. Corn is grown as feed for swine and cattle, both of which are cash income crops. Wheat is grown for feed and for sale, but much the greater amount for sale. Other crops are: oats, sweet corn, rye, buckwheat, barley, wheat mixture (for feed only), soy beans, tobacco, potatoes and other vegetables.

The production of swine is of greatest importance in the Wilmington Region. Over 150,000 head are raised annually. Dairy products, sheep, poultry and some feeder cattle are secondary.

Most of the livestock moves from the Wilmington Region to Cincinnati, Dayton, Columbus and Washington Court House, while a little goes to more distant points. The weekly auction at Wilmington serves as a concentration point. Movement of livestock is about equally divided between the railroad and motor truck. All stock shipped to the Dayton market moves by truck.

The Clinton County Lamb and Fleece Improvement Association markets lambs and wool for members in Clinton County. The Clinton County Farm Bureau purchases wool in the county for shipment elsewhere.

The most important dairy product in the Wilmington Region is fresh milk. Two dairies supply the city of Wilmington. Four truck routes are operated throughout the county by dairies in Dayton, Cincinnati, Washington Court House and the condensing milk plant at Hillsboro.

Poultry products, eggs, chickens and turkeys, are sold to hucksters, regular customers in town or to local dealers. Most of those sold are shipped by the local dealers to Dayton and Cincinnati.

The total cash income realized by the farmers of the region in 1942 was approximately $8,000,000. That received from livestock products exceeded 90 per cent of this total. Swine lead with 63 per cent; dairy products were next with 12 per cent; poultry, 8 per cent; cattle, 4 per cent; and sheep, 3 per cent.[18]

While livestock provide the source of the farmer's cash income, the production of grain for feed is of basic importance. Among those grains, wheat serves not only for feed but as a direct cash crop. Its sale accounted for 6 per cent of the cash income in 1942.[19] Most of the grain moves through the elevators at Wilmington.

The only mineral of economic importance in the region is Niagara dolomite. This formation has been quarried at various locations in the county. At the present time one quarry is in operation, at Melvin, 7 miles east of Wilmington.

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[17]Map, Type of Farming Areas in the United States, Dept. of Agric., Bureau of Rural Economics, 1936.

[18]Morison, F. L., and Falconer, J. I. "Estimated Gross Cash Income to Ohio Farmers from Sale of Agricultural Products and from Agricultural Adjustment Agency Payments, by Counties, 1942." Dept. of Rural Economics, Mimeographed Bull. No. 171. O. S. U., 1943. p. 8.

[19]Morison and Falconer, op. cit., p. 8.

Manufacturing in Wilmington shows no relation to the raw materials available. All of the manufacturing is in the metal industries, namely, the production of auger bits, furnaces, grey cast iron, and products made from this iron. Most of the raw materials used by the four plants come from a distance of over 50 miles and occasionally from as far as Pennsylvania and Alabama. The market is both state and national. This is the largest group of metal manufacturers in the eastern half of the Little Miami Valley. Their labor supply, about 500 employees, mostly men, is drawn from the region and within a radius of 20 miles.

The retail business of the town depends to a large extent upon the surrounding farming community. Certain types of industry are definitely related to the agricultural economy. Elevators, feed mills, agricultural implement stores, and hardware stores supply the needs of the farmers. The town itself, with a population of only 6,000, could not alone support these establishments.

Wilmington and the surrounding agricultural area are an integrated unit. The city depends upon the purchasing power of the farmer as does the farmer upon the city as his market and a place in which to purchase his needs.

Catalog of Illinois Algae

The advancement of knowledge of any group of living organisms is proportionate to the time and effort expended by individuals who collect, identify, describe and record their findings in such a manner that their colleagues may judge critically their own labors. Periodically, if these researches are to retain their intrinsic value, it becomes imperative that they be criticized in the light of new discoveries and integrated into a workable whole. Dr. Britton has accomplished this to a remarkable degree for the algae of Illinois.

The 962 entries are distributed through 178 genera and constitute, with the exception of fifty names whose validity or taxonomic position are inconsistent with modern algal interpretation, a review of all Illinois algae. A detailed review and classification of the literature concerning the state provides a basic starting point for future taxonomic studies. Each species in the compendium is accompanied by detailed distribution data concerning the exact locality within the County, the collector and the date of collection. Such data will be of inestimable value to the Illinois Alogolgist and of only slightly less interest to his co-workers in other states.

—*C. E. Taft.*

A Catalog of Illinois Algae, by Max E. Britton. Northwestern University Studies in the Biological Sciences and Medicine, No. 2. 1944. $3.00.

MYRMECOLOGICAL TECHNIQUE

I. The Use of Ether in Collecting Ants

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Some years ago while collecting with Professor Fred Hitchcock, physiologist at Ohio State University, a nest of *Camponotus caryae* Var. (?) the limb containing the nest was wrapped up in the ground cloth carried by collectors, brought back to the Put-in-Bay laboratory where it was opened up in an unoccupied room on a hard flat floor and the attempt was made to capture all of the ants for a careful count. The species of this group are so extremely active that it was difficult for the two of us with tweezers and vials of alcohol to keep many of the ants from escaping from off the cloth. Professor Hitchcock suggested, "Would it hurt the specimens to etherize them?" As ether was handy it was used on the nest. Immediately the operation changed from one of desperation to one of placid comfort as we picked up the sleeping ants. Ever since that time the writer has carried in his collecting bag at least a half pound of ether. Where collecting has been from an automobile or motor boat, among accessories is another half pound or pound of ether.

I wish to point out that our knowledge of many species of ants is extraordinarily imperfect because the collector too frequently picks a half dozen specimens out of the nest into a small vial of 70 per cent alcohol, then when he returns to the laboratory and checks his material carefully he finds that he would like a much greater series of that particular species. Too frequently the species runs from minute minores through a long series of sizes of mediae into a few very active majores. The temptation is always to collect the large ants which are usually brighter colored and more conspicuous. The other possibility comes up that the few majores may escape in active species before the tweezers can be gotten into action and the collector may even wind up with simply a small number of minores which in the hands of a taxonomist not widely familiar with the group, could easily be described as a new species. Probably in the literature on North American ants a number of such have been described on either majores alone or minores alone. In certain species we suspect the work of some of our most eminent myrmecologists especially European workers on American material. The museum material just does not agree with our own field experience with related species in the same group.

Ether involves a small expense which to the majority of students of ants can be charged back to laboratory funds. For those who have to pay for it out of their own personal funds I would suggest that the cheap, impure ether which, before the war could be purchased in almost any sporting goods store, be used instead of the medical grade which is found about scientific laboratories. This cheaper grade of ether is used by out-board motor boat enthusiasts who pour it into the gasoline tank in order to get the boat up into the level of dangerous speeds. All racing boats use it. It usually costs about half as much as medical ether and comes in cans of one pound each. A comfortable amount to carry is one-half pound which quantity can be transferred to a medical ether can from the larger can of crude ether.

Some provision has to be made in the bag that the ether is carried upright as it tends to flow past the best of corks if it lies on its side. A leak of ether in the bag could produce serious results when the collector lights a cigarette. It can burn the collector badly when it seeps on to areas of thin tender skin.

The use of ether is especially desirable in collecting timber ants which from their environment are all active, fast climbers. In the capture of these, as soon as an opening is suspected of containing an ant's nest, a few drops or a teaspoonful

of ether is poured about the opening and into it. This stops any sudden egress of ants while the opening is being enlarged. During the process of cutting into the nest more ether is applied as needed when pockets of ants are discovered which are not fully asleep. The chunks of wood or other material can then be transferred to the ground cloth where the entire nest is collected almost at one's leisure.

In the case of the forms of *Camponotus caryae* it is very essential that the collecting be done in the late summer or fall or any time from then until the flight in early spring, and that the collection from the nest contain all forms from the minute minores to the largest majores. We have nests in this group where we are positive we have collected all individuals during cool weather in late summer and have succeeded in such nests in finding only one or two giant majores among a total population of several hundred individuals. These majores are nearly the size of the queen and give an entirely different picture of the species than one in which the two or three giant majores have escaped. Such careful collecting of entire nests of *caryae* in Ohio during the last several years has given us an entirely different picture of the local species from that obtained before ether was used, when frequently nine-tenths of the individuals of a nest would escape during the collection. Thus the use of ether has eliminated two or three suppositions from the Ohio list.

We find ether equally valuable in collecting ground *Formica*. Here usually much more is required; when we find that we have the nest of an unusual ant, particularly in the difficult *rufa* group, we pour into the opening of the nest several tablespoonfuls of ether and then with a long handled shovel which we always carry, proceed to dig the nest to the bottom, carefully etherizing all new parts invaded, at least until we find the queen. The soil from the nest can be shoveled onto the ground cloth (3 ft. square or more) and sorted very carefully. The error in such collecting is then reduced to the field workers which do not arrive during the operation. These usually come in just often enough that they can be picked up individually especially if the collector knocks them into the dug pit where they have difficulty in scrambling out. In such nests the majores, if any, are usually in the top of the nest and otherwise would escape very rapidly, as in the case of *caryae*. In many nests the majores are rather few, and very active. Too frequently the minores are a foot or more beneath the surface and are only in the top of the nest by accident. We could cite various museum series of type material where apparently the collector merely used a hand trowel and collected a dozen or so specimens out of the top galleries. From what we know of related species there were probably minores of an entirely different size and color in the deeper layers of the nest. Etherization permits the collector to take his time and dig to the bottom of the nest or until he is sure he has all possible forms and enough material to pass specimens to other workers.

In various species during the pre-swarming period the males will be found about the nest opening or, in timber ants, frequently a foot or two above it, and may escape the collector because of their extremely nervous activity and their location high up instead of below the entrance.

In ants which inhabit acorns or snail shells we have available in the car or boat a basket of hospital urine sample bottles with appropriate round, tight corks—at least fifty such bottles. We usually have a student or other helper who carries in his pocket several of these bottles and who collects by placing any suspicious acorn with wormhole in a bottle which he corks tightly. He delivers the tightly corked bottle to the ground cloth where the acorn is removed from the bottle and is etherized through the hole before it is opened enough to determine whether it contains a nest or not. If it contains no ants it is discarded. If ants are seen it is replaced in the bottle and tightly corked and taken back to the laboratory for further study. In this manner instead of getting a few partial nests under one acorn tree we have found as many as a half dozen species of ants and are fairly certain that we have the entire nest in each case except for the field ants not at home.

At the laboratory, knowing that we have ants in each bottle brought in, we put a few drops of ether in each bottle before examination and then empty the bottle onto the laboratory table.

Ether has had less usefulness in large nests and in nests so placed that it is difficult to explore them. In large nests the ether would have to be used by the quart to control the whole nest. I am thinking of the great mounds of raw dirt built by the tree ant, *Formica exsectoides* Forel, frequently called the Allegheny mound building ant. Under favorable conditions, particularly in groves of yellow poplar (*Liriodendron tulipifera* L.) whose branches harbor vast numbers of honey dew producing insects, the mounds will be over forty inches high and six to eight feet in diameter. Ether is of little value in such vast colonies. The other type of large nest is that made by various varieties of *Formica rufa* across southern Canada in the talus slopes of limestone slabs under the cliffs of the geologists' Niagra Formation. In such a nest both hands have to be used to turn a slab three inches thick and two to three feet in diameter. Before the ether contained can be picked up the ants have dived into the crevices between even larger stones. One is lucky to capture a few dozen out of hundreds in the top chamber under the covering slab. This is where we wonder how soon inventive genius will produce a pocket sized steam shovel. Only a strip miner has a technique that could open such a nest to the bottom. A third type where ether has little usefulness is in the large flat nest areas produced in Ohio south of the glaciated area by what we class as *Formica fusa subsericea* Say. These nests are areas of raw dirt frequently ten feet in diameter with dozens or even a hundred or so openings. What appears to be the same species builds similar nest areas along the sandy shores of Mackinac Straits, Mich. In these large nests the transporting powers of the collector do not fit the amount of ether needed nor does the staying powers of the ether fit the collecting speed of the forceps wielding ant student. So far only rough estimates on thoroughly etherized fractions of such a nest have to be used in population estimates.

Ether has lessened value in collecting very minute species where the nest is a series of thread sized galleries in substrate of a color almost matching that of the ant. I think of Stenamma, Brachymyrmex, Proceratium, Ponera and many species of Strumigenys. These are so small that they can escape detection when they are not moving. They are usually more easily collected when shovelled onto a cloth. Here they are so slow and nest numbers are so low that few escape. If in an acorn or well defined chamber in wood sometimes a drop or two of three helps hold them until collected. Leptothorax only slightly larger is so active that ether is usually needed, and the same for the very fast species of *Iridomyrmex*.

Our experience with ether is that it does not injure the ant. On Canadian trips we have opened up nests of rare forms of *rufa* and when we found that they were within a few days of the emergence of the winged brood from the cocoon, have thoroughly etherized the nest, picking out samples of the various castes available, and have closed the nest to come back two weeks later to find it as active and contented as if it had not experienced a fairly complete etherization. Probably ants that ether actually struck were killed, but care can be taken not to pour the ether directly on masses of ants. We used it also in such preflight broods brought into the laboratory for emergence. We cannot find that etherization injures either the workers brought along to care for the brood or the brood itself, providing that ether is not poured directly onto the living ants. This gives one complete control of living laboratory samples.

We might observe in closing that studying ants in the field is work and not a holiday or picnic. More and more rarely do we merely sample nests and only where we feel fairly certain that we can return within a few days. The ant sampler merely makes trouble for the taxonomist and the museum man. Science from its nature is thoughtful of others and cooperative in its better techniques.

THE MEXICAN SPECIES OF IDIODONUS (HOMOPTERA–CICADELLIDAE)

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The Genus Idiodonus was described by Ball[1] in 1936 to include several species of blunt headed North American leafhoppers. *Jassus kennicotti* Uhler was made the genotype. With few exceptions these are tree inhabiting forms. In Mexico they have been collected from trees and shrubs all the way from the low desert shrub vegetation near sea level to 12,000 feet elevation from evergreens in some of the higher mountain ranges. More species have been found at altitudes of 5,000 feet or more than at lower elevations.

Only a few species apparently live at low altitudes. *Schwartzi* has been taken in the low desert and up to 5,000 feet elevation. At 5,000 feet elevations several species are found, some of which, *vinculus*, *claustrus* and *copulus* for instance, have not been taken at higher elevations. Others such as *acus*, *wickhami*, *albocinctus*, *latidens* and *nigridens* are found all the way from 5,000 to 10,000 feet and some even higher. A group of species, such as *rubellus*, *spatulus*, and *bicinctus* have not been found at elevations lower than 7500 feet. *Apertus*, *diserus*, *goodi*, *incidus* and *incisurus* have been taken only at 8500 feet elevation or higher while *titulus*, *insculptus* and *edentulus* have not been taken at elevations of less than 10,000 feet. Many of the species of this group are definitely alpine in distribution.

Very little work has previously been done on the Mexican fauna and as a result 30 of the 35 species treated in this paper are described as new. The largest group of related species is the *belli* series. The *kennicotti* group is represented by a few species, such as *vinculus*, *spatulus*, *copulus* and *apertus*. *Latidens* and *bakeri* are species apparently closely related to *terminalis*.

Thamnotettix fasciaticollis Stål is a species which is apparently represented in this material, but since the description will apply to any one of several species, and I have no authentically identified material, I am not able to definitely place the name upon any one of the species of this group.

The genus *Colladonus* was also described by Ball at the same time as *Idiodonus*, and *Thamnotettix collaris* Ball designated as the genotype. No specimens of the *collaris-clitellarius* group have been found in Mexico and it is doubtful if these can be distinguished as a generic group.

While this is not a completed list of the Mexican species it does bring together all available material at this time which has been collected by Dr. Alphonse Dampf, Professor of Biology at the Escuela Nacional de Ciencias Biologicas located at Mexico City, D. F., and the material collected by Drs. C. C. Plummer, J. S. Caldwell, E. E. Good and the writer during two field expeditions in many ecological habitats and various areas of Mexico. The author desires to express his appreciation to all of these colleagues for assistance rendered in the field studies.[2]

The color pattern of the head, pronotum and scutellum, are quite distinct and uniform and have proven to be good characters for the separation of species. The last ventral segment of the female is also quite a good structural character for the distinguishing of species. The male characters in this group have not proved to be of significant taxonomic value.

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[1]Bulletin Brook. Ent. Soc. 31: 57, 1936.

[2]Since completing the manuscript new type material has been collected in Mexico (1945) by Stone, Plummer, Shaw, Balock, Elliott, Hershberger and the author. These type designations have been added to the appropriate descriptions.

The type material of all the species described in the following pages is in the private collection of the author.

KEY FOR SEPARATION OF SPECIES OR GROUPS BY COLOR PATTERNS

1. With black markings on apex or margin of vertex....3
   Without black spots or bands on vertex margin....2
2. Yellow, without any markings on vertex and pronotum....**graeculus**
   With a row of fused spots just above margin....**incisurus**
3. Vertex with black spots or a transverse band, often interrupted at middle between the anterior margins of eyes....6
   Vertex without black markings except on margin....4
4. Pronotum with a definite pale transverse band across middle or posterior half....5
   Without a pale transverse band on pronotum....**schwartzi**
5. Pronotum with a broad transverse band on the posterior half....**tubulus**
   Pronotum with a narrow band at middle, curved convexly forward....**rubellus spatulatus**
6. Usually with an uninterrupted black transverse band between eyes....7
   Markings usually in the form of broken bands or spots....11
7. With conspicuous black spots, some of which are merged, on the entire anterior portion of pronotum....**insculptus**
   Without spots, often with a black band on anterior portion of pronotum....8
8. With a definite conspicuous black band on anterior margin of pronotum....9
   With only traces of black markings on central anterior portion of pronotum....**clathrus**
9. With a black band on anterior margin of pronotum only....**mexicans goodi titulus claustrus**
   A band on posterior margin or disc as well as one on anterior margin....10
10. A distinct band on disc, not close to posterior margin....**bicinctus**
    With a distinct band on posterior margin....**pravus dampfi acus**
11. Black spots irregular and often quite small....13
    Black spots transverse often appearing as portions of broken transverse bands....12
12. Usually a pair of short transverse spots—not an interrupted band, **copulus diserus bakeri latidens plummeri**
    Appearing more as an interrupted band between eyes, **caldwelli wickhami albocinctus** and **verecundus**
13. Spots close to, usually touching eye....14
    Spots not touching eye....15
14. Spots rather small, narrow....**vinculus beameri**
    Spots larger, irregular in form....**incidus edentulus turpiter**
15. Spots just back of each ocellus rather large, rounded....**anademus excavatus**
    Spots above ocelli quite small....**apertus nigridens**

Idiodonus schwartzi (Ball.)

Thamnottix schwartzi (Ball) Canadian Entomologist 43: 197, 1911.

A broad headed species with margins almost parallel. Length female 5.5 mm.

Vertex broadly rounded, twice as wide between eyes at base as median length.

Color: Vertex white with red ocelli and a pair of small black spots on anterior margin about equidistant from each other and the eyes. A pale yellowish band extending between eyes across the basal portion. Pronotum dull gray tinted with yellow on anterior margin. Scutellum with the basal angles fulvous, median portion white, tinted with yellow. Elytra whitish subhyaline. Claval veins white. Veins on the disc brown. Face and beneath creamy.

Genitalia: Female last ventral segment with posterior margin produced and sinuate, slightly indented at center forming two broad slightly produced lobes either side of middle.

Specimens have been collected at Saltillo, Coah., Mexico, elevation 5000 ft., June 10, 1931 (M. F. 2058); Montemorelos, N. Leon, Mexico, elevation 1500 ft., June 3, 1930 (M. F. 2023) and Hacienda Fresno, Coah., Mexico, (M. B. 328) by Dr. A. Dampf. One specimen apparently belonging to this species was collected from desert shrubs north of Monterrey, N. Leon, elevation 1700 ft., September 22, 1941, by Good, Caldwell and DeLong.

Idiodonus apertus n. sp.

Resembling *schwartzi* in general form and appearance but with distinct color markings and female genitalia. Length 5 mm.

Vertex bluntly produced almost twice as broad between eyes at base as median length.

Color: Vertex white, ocelli orange, two round black proximal spots at apex and a small brownish spot behind each ocellus on disc. Pronotum dull brown, a conspicuous pale transverse band across the disc marked with scattered flecks of reddish pigment. Scutellum creamy white, basal angles fulvous. Elytra grayish, subhyaline, claval veins white. Veins on the corium dark. Face pale, sutures and faint markings of arcs brownish, beneath pale marked with brown. Ovipositor brown.

Genitalia: Female last ventral segment with the lateral margins rounded to a produced tooth either side of a deep, squarely excavated median third extending more than one-third the distance to the base and which bears a broad sunken median spatulate process extending almost to the posterior margin of the segment.

Holotype female collected at Puebla, Pue., Mexico, elevation 8500 ft., October 18, 1941, (K-78) by Plummer, Caldwell, Good and DeLong.

Idiodonus rubellus n. sp.

Resembling *osborni* in general appearance but with different color markings. Length 5.5 mm.

Vertex broadly rounded, almost parallel margined, more than twice as wide between eyes at base as median length.

Color: Vertex creamy white tinted with orange, ocelli red with a pair of rather small round black spots at apex. Vertex, pronotum and scutellum with numerous red flecks. Pronotum dull brown washed with yellow, with a narrow inconspicuous pale median transverse band. Scutellum orange brown with a black impressed transverse median line, narrowly white margined on either side at middle. Elytra brown subhyaline. Veins and claval suture narrowly white. Veins on anterior portion of the wing inconspicuous. Face creamy, rather heavily flecked with red.

Genitalia: Female last ventral segment with the lateral angles produced, between which the posterior margin is deeply concavely excavated either side of a median rather broad spatulate process which does not extend to the lateral angles and is slightly notched at apex.

Holotype female collected at Mexico City, D. F., Mexico, elevation 7500 ft., September 1, 1939, by the author.

Idiodonus vinculus n. sp.

Resembling *kennicotti* in form and general appearance but with different color markings. Length 6 mm.

Vertex broad and blunt only slightly produced, about two and one-third times as broad between eyes at base as median length.

Color: Vertex yellow with a pair of round black spots at apex. In male there is a narrow brown transverse band between the anterior margins of the eyes. In female the ends of the band are marked with a black spot the central portion of which is reddish brown. Pronotum dark brown with a median white transverse band, and a narrow band along posterior margin. Scutellum reddish brown with a median transverse impressed black line, margins on posterior half, narrowly white. Elytra dark brown subhyaline, veins paler. Face yellow.

Genitalia: Female last ventral segment with produced lateral angles, between which the posterior margin is rather deeply excavated either side of a broad median produced tooth half the width of segment which is shallowly notched at apex. Male plates triangular, elongate, tapered from base to long pointed apices.

Holotype female collected at Jacala, Hgo., Mexico, elevation 5000 ft., September 26, 1941. Allotype male taken on Acapulco Road, Mexico, November 22, 1938. Both collected by Caldwell, Good and DeLong. Also paratype females collected at Mexico City, September 26, 1945, elevation 8500 ft. and at K-287 Jalapa Rd., October 14, 1945, elevation 7000 ft., by Shaw, Elliott, Hershberger and DeLong.

Idiodonus spatulatus n. sp.

Resembling *vinculus* in form and color but female with a spatulate last ventral segment. Length 5–6 mm.

Vertex broadly, roundedly produced, more than twice as wide between eyes at base as median length.

Color: Vertex yellow with minute red flecks, a pair of round black spots at apex. In the male there is a narrow interrupted transverse brown band between the anterior margins of the eyes. Pronotum brown, darker on posterior two-thirds, a narrow white transverse band across middle. Scutellum orange, a median impressed dark transverse line and margins of posterior portion white. Elytra dark brown, subhyaline, veins paler.

Genitalia: Female last ventral segment with produced angles, between which the posterior margin is angularly excavated almost halfway to the base either side of a broad spatulate median process, the apex of which does not extend to the lateral angles of segment. Male plates elongate, triangular, apices long, tapered.

Holotype female and allotype male collected at Mexico City, D. F., Mexico, elevation 7500 ft., September 1, 1939, from shrubs by Plummer and DeLong. Paratype females collected at Mexico City, September 26, 1945, elevation 8500 ft., by DeLong, Hershberger and Elliott.

Idiodonus copulus n. sp.

Resembling *kennicotti* in general form but with a narrower head and distinct coloration. Length, female 5.5 mm.

Vertex broadly rounded, almost parallel margined, more than twice as broad between the eyes as median length.

Color: Vertex white, ocelli red, two large round black proximal spots at apex, a triangular black spot just behind each ocellus, a broad orange brown transverse band between eyes at base. Pronotum dark brown with a median transverse white band. Scutellum, basal half orange brown. Median transverse impressed dark line from which a dark brown elongated spot extends to the margin either side of apex, posterior half white. Elytra smoky subhyaline. Veins of the clavus white. Veins anterior to the claval suture black. Face pale with black sutures and conspicuous dark brown arcs which fuse in a line either side of middle.

Genitalia: Female last ventral segment long, strongly, angularly produced from the lateral angles to form a pair of rather broad blunt teeth either side of a short V-shaped median notch.

Holotype female collected at Carapan, Mich., Mexico, elevation 5000 ft., (K-432) October 2, 1941, by Caldwell, Plummer, Good and DeLong. Paratype female taken at Taxco, Gro., Mexico, elevation 5700 ft., (M. F. 1554) December 23, 1929, by Dr. Dampf; and at K-287 Jalapa Rd., October 14, 1945, elevation 7000 ft., by Shaw, DeLong, Hershberger and Elliott.

Idiodonus caldwelli n. sp.

Resembling *apertus* in general form but with more produced head, distinct coloration and genital characters. Length 4.5 to 5.5 mm.

Vertex bluntly produced, almost twice as wide between eyes at base as median length.

Color: Vertex orange yellow with two round black spots at apex and a transverse dark brown band near base, interrupted at the middle, and with the portion next to the eyes curved posteriorly. Pronotum orange yellow with a narrow anterior black margin and the posterior discal portion brownish. Scutellum orange yellow with semi-circular black spots on the basal angles. Elytra smoky and subhyaline. Claval veins yellow, claval suture broadly orange yellow and the veins anterior to the claval suture black. Face yellow with sutures and remnants of several pairs of arcs, brown.

Genitalia: Female last ventral segment convexly rounded to form prominent blunt teeth between which there is a deep narrow rounded excavation either side of a broad median blunt spatulate process which does not extend quite to the posterior margin of the teeth on either side. Male plates triangular, convexly rounded to elongate pointed apices.

Holotype female collected at Jacala, Hgo., Mexico, elevation 5000 ft., September 26, 1941, by Caldwell, Good and DeLong. Allotype male from Oaxaca, Oax., Mexico, collected June 10, 1935 (M. F.-6196) by Dr. Dampf. Paratype males and females from Chilpancingo, Gro., Mexico, elevation 4500 ft., October 25, 1941; Iguala, Gro., Mexico, elevation 2300 ft., October 25, 1941; Puento de Ixtla, Mor., Mexico, October 21, 1941; Uruapan, Mich., Mexico, elevation 5000 ft., October 1, 1941; Tuxpan, Mich., Mexico, elevation 4000 ft., October 5, 1941; Zitacuaro, Mich.,

Mexico, elevation 6700 ft., September 29, 1941; Carapan, Mich., Mexico, elevation 5000 ft., September 30, 1941; Taxco, Gro., Mexico, elevation 5700 ft., October 26, 1941, and Cuernavaca, Mor., Mexico, elevation 4900 ft., September 8, 1939, collected by Plummer, Caldwell, Good and DeLong. I take pleasure in dedicating this species to Dr. J. S. Caldwell.

Idiodonus beameri Ball.

Idiodonus beameri Ball. Bull. Brooklyn Ent. Soc. 32 : 28, 1937.

A blunt headed species with an irregular row of black spots along vertex margin. Length 5.5 mm.

Vertex bluntly produced, almost parallel margined, twice as wide between eyes at base as median length.

Color: Vertex brown with a pair of large round proximal spots at apex. An elongated triangular black spot either side next ocellus which tapers to a point just above the apical spots. A quadrate spot just below ocellus between eye and ocellus another next each eye above ocellus. Pronotum dark brown. Scutellum yellow, basal angles brown, a heavy impressed brown cross on posterior half. Elytra brownish subhyaline, veins pale on clavus, dark brown on corium, costa broadly white. Face yellow.

Genitalia: Female last ventral segment almost truncate with a narrow V-shaped notch at middle reaching one-third the distance to base. Male plates elongate, roundingly narrowed to form long filamentous apices.

Specimens of this species were collected at Uruapan, Mich., Mexico, elevation 5500 ft., October 1, 1941; Carapan, Mich., Mexico, elevation 5000 ft., October 2, 1941; Puebla, Pue., Mexico, elevation 8500 ft., October 18, 1941; Zimapan, Hgo., Mexico, elevation 6000 ft., September 26, 1941; Zitacuaro, Mich., Mexico, elevation 6700 ft., October 5, 1941, and La Guarda, D. F., Mexico, elevation 9800 ft., October 26, 1941. All specimens were collected from pine by Plummer, Good, Caldwell and DeLong. In 1945 numerous specimens were collected at Deserto des Leones, D. F., in October: at Cruz Blanca, Vera, in October and at Rio Frio, D. F., in October by Shaw, DeLong, Hershberger and Elliott.

Idiodonus wickhami Ball.

Idiodonus wickhami Ball. Bull. Brooklyn Ent. Soc. 32 : 27, 1937.

A blunt headed species with red flecks on vertex, pronotum and elytra, with conspicuous black marks. Length 4 to 4.5 mm.

Vertex produced, bluntly angled, about twice as wide at base as median length.

Color quite variable. In well marked specimens the red flecks are conspicuous in the color pattern but may be entirely wanting. Vertex with a pair of elongated black spots at apex on margin, a median quadrate black spot just above these. A pair of black spots just beneath each ocellus and a rather narrow transverse black band just above ocelli between the anterior margins of the eyes which is slightly interrupted at the middle. Pronotum with a round, black spot behind each eye on anterior margin and irregular black mottling. Scutellum pale, with a pair of elongate median spots just back of pronotum, and a transverse black line on middle. Elytra pale, tinted with fuscus. Veins pale, often with rows of reddish flecks and darker pigment on veins. Face yellowish, heavily marked with broad dark arcs which are fused either side of median line and with black marginal sutures.

Genitalia: Female last ventral segment with the posterior margin convexly rounded from lateral margin and sinuate. Male plates elongate, triangular, concavely rounded to rather long acutely pointed apices.

This species is very common in the high altitude area and has been collected at Mt. Popo, Mexico, elevation 11500 ft., September 28, 1941; Mexico City, D. F., Mexico, elevation 7500 ft., September 1, 1939; September 16, 1923; La Guarda, D. F., Mexico, elevation 8500 ft., September 5, 1939; Chapingo, D. F., Mexico, elevation 9900 ft., March 31, 1924; Tlalpam, D. F., Mexico, September 16, 1923; Zitacuaro, Mich., Mexico, elevation 6700 ft., September 29, 1941; Carapan, Mich., Mexico, elevation 5000 ft., October 2, 1941; Toluca, D. F., Mexico, elevation 9700 ft., September 29, 1941; Puebla, Pue., Mexico, elevation 8500 ft., October 18, 1941; Rio Frio, D. F.,

Mexico, elevation 10300 ft., October 7, 1941; Zacapu, Mich., Mexico, elevation 6500 ft., October 4, 1941. Collected by A. Dampf, Caldwell, Plummer, Good and DeLong.

Idiodonus belli (Uhler)

Jassus belli Uhler. U. S. Geological and Geographical Survey of the Territories Bulletin, 3 : 471, 1877.

A blunt headed yellowish species with black markings. Length 5 mm.

Vertex bluntly angled, rounded at apex, almost twice as broad at base as median length.

Color: Yellow with black markings. Vertex with a pair of round black proximal spots on margin at apex. A transverse black band between the anterior portion of the eyes which is enlarged at each end next the eye. Pronotum yellow, the anterior margin broadly marked with black, a narrow black margin posteriorly. Scutellum yellow with a T-shaped black marking on the posterior half. Elytra subhyaline, veins bright yellow. Face yellow, with the sutures, antennal pits and portions of the arcs on the face black. Beneath, thorax black, abdomen yellow with a black ovipositor.

Genitalia: Female last ventral segment almost truncate with a short narrow median incision. Male plates rather short, convexly rounded to blunt apices. Pygofer extended the length of the plates beyond their apices.

This is the common species of this group found in the Rocky Mountain area of the United States, no specimens which agree with this species have been taken in Mexico.

Idiodonus claustrus n. sp.

Resembling *belli* in general appearance but with more produced head, distinct markings and genitalia. Length, female 4.5 mm.

Vertex produced, bluntly angled, less than twice as wide between eyes at base as median length.

Color: Vertex yellow with two large black spots at apex and a rather large spot beneath each ocellus, a broad black transverse band between the anterior portions of the eyes which is enlarged and curves basally at each end. Pronotum yellow, tinged with green, with a rather broad black anterior margin and some brownish markings on the disc. Scutellum yellow, black-margined anteriorly. A large T-shaped marking on the posterior half. Elytra black, subhyaline. The veins broadly conspicuously marked with yellow. Face yellow, sutures black, faint traces of black arcs on either side.

Genitalia: Female last ventral segment with the lateral margins broadly rounding to posterior margin which is slightly concave with a median, short, rather narrow, semi-circular excavation which is broadly black margined. Male plates small, triangular, elongate with pointed apices.

Holotype female collected at Orizaba, Ver., Mexico, elevation 4000 ft., October 17, 1941, by Plummer, Caldwell, Good and DeLong. Allotype male and paratype male collected at Las Cosca, Chiapas, Mexico, August 12, 1926, by Dr. Dampf. Paratype females were collected at Cruz Blanca, Vera., October 13, 1945, elevation 7000 ft., by Shaw, Hershberger, DeLong and Elliott.

Idiodonus bicinctus n. sp.

Resembling *belli* in general appearance and coloration but smaller and with different markings. Female 4 mm.

Vertex produced forming a blunt apex, about one-third broader at base than median length.

Color: Vertex yellow with a pair of large round black spots at apex and a minute black spot just beneath each ocellus. A broad black transverse band between the anterior margins of the eyes. Pronotum yellow with two black transverse bands, one is on the anterior margin of the pronotum, another on the posterior portion of the disc which does not extend to the lateral margins, giving the appearance of two black and two yellow bands. Scutellum yellow with a narrow basal black broken band and a rather conspicuous T-shaped black marking on the posterior portion. Elytra black subhyaline, veins conspicuously yellow except on costal and apical portion. Face yellowish with sutures and portions of arcs on face black.

Dorsal view of heads of species of Idiodonus showing the most conspicuous color markings.

Genitalia: Female last ventral segment with posterior margin bluntly, slightly concave, with a shallow narrow median notch. Median portion of segment black margined, giving the appearance of a deeper excavation.

Holotype female collected at Mexico City, D. F., Mexico, elevation 7500 ft., September 13, 1939, by the author. Paratype female, Mexico City, D. F., Mexico, June 12, 1924, collected by Dr. Dampf (M. B. 62).

Idiodonus dampfi n. sp.

Resembling *belli* in general appearance but with different color markings and distinct female genitalia. Length 4.5 mm.

Vertex blunt, almost twice as long at base as median length.

Color: Vertex creamy yellow, with a pair of large round black spots at apex and a smaller spot each side beneath the ocellus. A broad transverse black band between the anterior portions of the eyes, the posterior portion tinted with pale brown. Pronotum yellowish with a black band on anterior margin shading to brown on the disc and a narrow black band on the posterior margin. Scutellum pale brownish with a rather faint inconspicuous T-shaped mark on the posterior half. Smoky to blackish hyaline with pale veins. Face pale brownish, sutures conspicuously black, portions of dark arcs on upper half of face.

Genitalia: Female last ventral segment strongly produced forming a narrow conspicuous rounded tooth either side of a square shaped median excavation which is truncated at the base and black margined. Male plates broad at base gradually tapered to acutely pointed apices.

Holotype female collected at Cordoba, Vera Cruz, Mexico, elevation 3000 ft., November 19, 1930, by Dr A. Dampf (M. F. 1962). Allotype male collected at Bella Vista, Mexico, September 17, 1933, by Dr. Dampf (M. B. 366). Paratype males collected at Cosomatepec, Ver., Mexico, November 30, 1924, (M. B. 103) and at Chapingo, D. F., Mexico, elevation 9900 ft., November, 1924, by Dr. Dampf. I take pleasure in naming this species for Dr. Dampf who is interested in a thorough study of the Mexican fauna and has spent a great amount of time in the field collecting and studying insect material. Paratype females collected on the Morelia Rd. at the borders of Mexico and Michocan on September 28, 1945, elevation 9200 ft., by Plummer, DeLong, Hershberger and Elliott.

Idiodonus verecundus n. sp.

Resembling *belli* in general appearance and coloration but with a more angularly produced vertex and distinct female genitalia. Length 4.6 to 5 mm.

Vertex strongly produced and angled, one-third wider at base than median length.

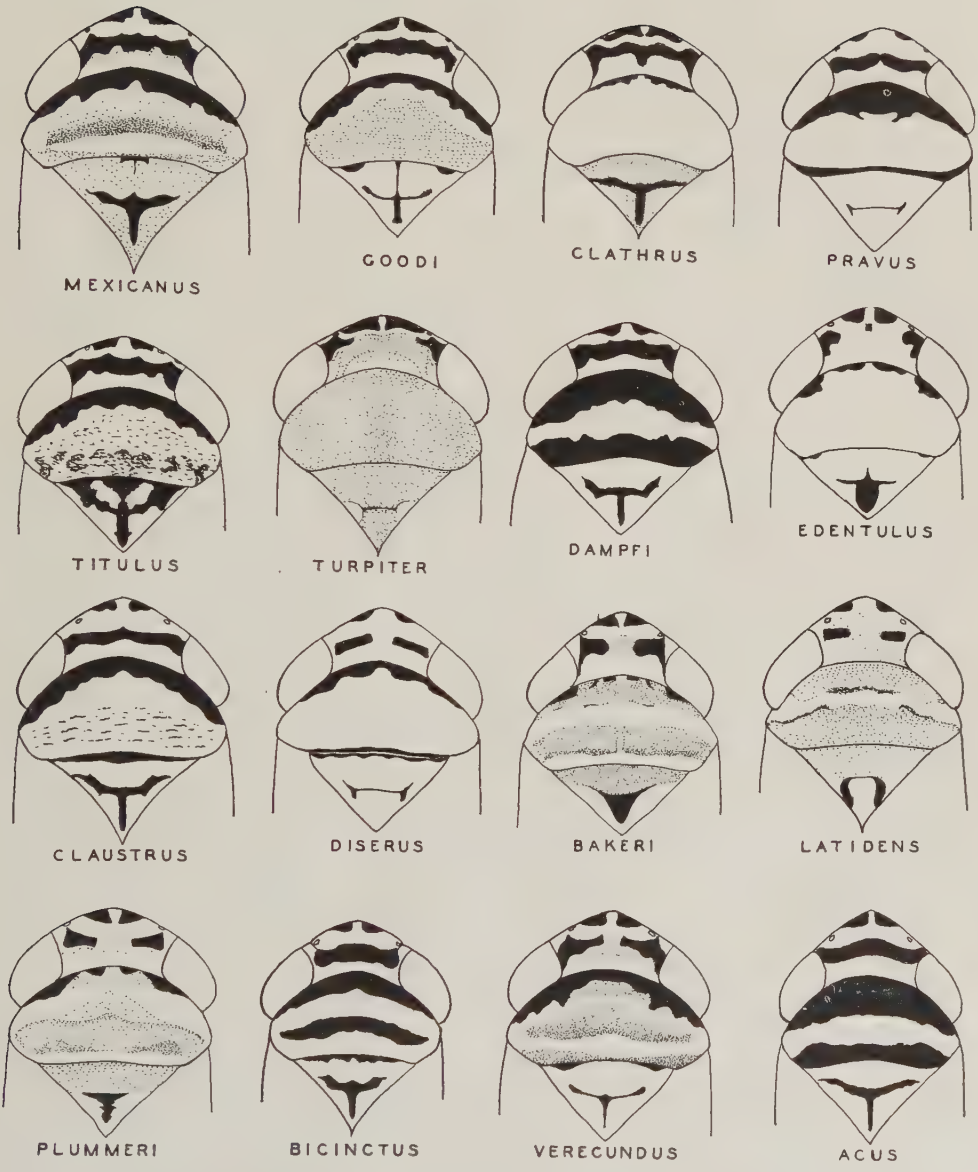
Color: Two large black spots at apex of vertex with a narrow pale portion between them. A rather conspicuous black spot beneath each ocellus, a rather broad black transverse spot each side between the anterior portions of the eyes which is narrowed on the disc and does not extend to the middle. Pronotum narrowly black margined anteriorly. Disc tinted with brown. Posterior margin dark brown forming a narrow pale band parallel to and not far distant from posterior margin. Scutellum pale brown with slight black markings on the basal angles, a T-shaped black mark on the posterior half. Elytra dark brown to black with pale veins. Face heavily marked with black or dark brown on sutures and arcs, beneath black or dark brown.

Genitalia: Female last ventral segment roundingly produced to median fifth which is shallowly, squarely, abruptly excavated about one-sixth the distance to the base.

Holotype female collected at La Guarda D. F., Mexico, elevation 9800 ft., October 26, 1941, (K-40), from pine by Good and DeLong. Allotype male and female paratypes collected from pine on the Morelia Rd. at the border between the states of Mexico and Michocan, September 28, 1945, by Plummer, Elliott, Hershberger and DeLong. Paratype male and females collected from pine at Rio Frio, D. F., October 18, 1945, elevation 9500 ft., by Hershberger, Elliott and DeLong.

Idiodonus acus n. sp.

Resembling *belli* in general coloration but with an angularly produced vertex and distinct genitalia. Length 4.5 to 5 mm.



Dorsal view of heads of species of Idiodonus showing the most conspicuous color markings.

Vertex angularly produced, about one-third wider between eyes at base than median length, Vertex distinctly pointed.

Color: Vertex white with a pair of large round black spots at apex. A rather broad, sinuate, black transverse band between the anterior margins of the eyes, posterior portion tinged with orange. Pronotum broadly black margined anteriorly, narrowly margined with black posteriorly, forming a broad transverse white band on posterior half which is bordered with orange anteriorly. Scutellum orange with a T-shaped black mark on the posterior half. Elytra smoky subhyaline, veins pale, costal margin appearing white. Face pale tinted with fuscous, with dark brown or black portions of arcs either side with sutures dark.

Genitalia: Female last ventral segment strongly produced from short lateral margins to a rather narrow rounded lobe either side of an excavation which bears a short round black tooth which does not extend to the posterior margin of the lobes. Male plates triangular, elongate with produced narrow apices.

Holotype female, allotype male and male and female paratypes collected at Rio Frio, D. F., Mexico, elevation 10300 ft., October 7 and 18, 1941; paratype male from Cuernavaca, Mor., Mexico, elevation 5000 ft., October 21, 1941. All material collected by Caldwell, Good, Plummer and DeLong. In 1945 paratype males and females were collected in forest areas of pine and fir from undergrowth at Deserto des Leones, D. F., on October 9 and 17 at elevations of 9500 ft., by Hershberger, DeLong and Elliott.

Idiodonus albocinctus n. sp.

A blunt headed species closely related to the *belli* group. Length 5.5 mm.

Vertex bluntly angled, less than twice as wide between eyes at base as median length.

Color: Vertex creamy white with a pair of large round black proximal spots at base. A very small black spot just beneath each ocellus. A transverse black band between the anterior margins of the eyes. This is slightly produced and sometimes interrupted at middle. Pronotum with a narrow black margin anteriorly, the anterior half and the posterior margin fulvous forming a rather broad pale transverse band across the posterior portion. Scutellum fulvous, a dark impressed transverse line across the middle. Elytra dark, smoky to black, with pale veins, face beneath creamy white with arcs and sutures dark.

Genitalia: Female last ventral segment strongly produced from lateral margins forming a rounded, rather narrow, produced lobe either side of a median broad shallow square excavation, almost truncate at apex and black margined. Male plates elongate, triangular, tapered to long acute tips.

Holotype female and allotype male collected at Deserto de los Leones, D. F., Mexico, elevation 9000 ft., July 11, 1924, (M. B.-72) by Dr. Dampf; Paratype males and females from Jacala, Hgo., Mexico, elevation 5000 ft., September 26, 1941; Carapan, Mich., Mexico, elevation 5000 ft., October 2, 1941, collected by Caldwell, Plummer, Good and DeLong. Paratype female from Chapingo, D. F., Mexico, elevation 9900 ft., June 11, 1924, (M. F.-196) by Dr. Dampf.

Idiodonus tubulus n. sp.

Resembling *albocinctus* in form and general appearance but without the black band on the vertex and with distinct female genitalia. Length 4.5 mm.

Vertex bluntly angled, twice as wide between eyes at base as median length.

Color: Vertex white with a pair of rather small dark brown spots at apex, the posterior half orange in the form of an irregular band between the eyes at base. Pronotum, anterior half pale brown, posterior portion white with a narrow, brown, posterior, marginal line. Scutellum pale brownish with a median transverse impressed dark line. Elytra pale brown subhyaline. Veins pale, face creamy tinted with fuscous, only faint traces of the arcs on either side.

Genitalia: Female last ventral segment rather short with posterior margins slightly produced to form a short blunt tooth either side of a broad shallow excavation which is slightly notched at the middle, forming what appears to be a pair of inconspicuous rounded sunken teeth. Male plates triangular, elongate, apices pointed.

Holotype female and paratype males and females collected at Chapingo, D. F., Mexico, elevation 9900 ft., November 25, 1924, by Dr. A. Dampf. Allotype male and male and female paratypes collected at Penon Marquez, D. F., Mexico, March 3, 1924, by Dr. Dampf.

Ventral view of last ventral segments of females of Mexican species of Idiodonus.

Idiodonus pravus n. sp.

Resembling *albocinctus* in form and general appearance but smaller and with distinct female genitalia. Length 4.5–5 mm.

Vertex bluntly angled, almost twice as wide between the eyes at base as median length.

Color: Vertex pale yellow with a pair of round black proximal spots at apex. A black spot beneath each ocellus. A rather narrow black band between the anterior margins of the eyes. Pronotum anteriorly and posteriorly margined with black; the anterior third dark brown; the posterior two-thirds yellow tinted with green. Scutellum fulvous with a median impressed transverse line. Elytra dark brown to black, veins pale, costal margin hyaline. Face yellowish tinted with brown, the sutures and portions of arcs brown.

Genitalia: Female last ventral segment concavely rounded from short lateral margins forming rather broad rounded lobes either side of a broad median excavation which extends more than one-third the distance to base and is broadly dark margined at the apex giving the appearance of a deeper notch.

Holotype female collected at Zitacuaro, Mich., Mexico, elevation 6700 ft., September 29, 1941. Paratype female from Carapan, Mich., Mexico, elevation 5000 ft., October 2, 1941. Both collected by Plummer, Caldwell, Good and DeLong.

Idiodonus diserus n. sp.

Resembling *albocinctus* in form and general appearance but with the transverse band replaced by a pair of transverse markings one on each side of vertex and with distinct female genitalia. Length 4.5 to 5 mm.

Vertex bluntly angled twice as long between eyes at base as median length.

Color: Vertex creamy white with a pair of rather large black spots at apex and a broad black dash either side of middle between eyes but not extending to eyes. Pronotum yellow tinged with green, a narrow black border both anteriorly and posteriorly. Scutellum yellow, bordered with black anteriorly with a median transverse impressed black mark. Elytra smoky, subhyaline with yellow veins. Face creamy white, sutures black, traces of brown arcs on each side of middle.

Genitalia: Female last ventral segment with lateral margins very short, posterior margins sloping to form a blunt lobe either side of a broad shallow excavation which is slightly notched at middle. The central apical portion heavily marked with brown, giving it the appearance of a deeper incision. Male plates triangular, rather broad at base with narrow pointed apices.

Holotype female collected at Chapingo, D. F., Mexico, elevation 9900 ft., June 18, 1929 (M. F. 210), male allotype and paratype males from the same locality collected March 17, 1924, by Dr. A. Dampf. Paratype male from Puebla, Pue., Mexico, elevation 8500 ft., October 18, 1941, collected by Plummer, Caldwell, Good and DeLong.

Idiodonus titulus n. sp.

Resembling *belli* in color pattern but a blunt headed, narrow, wedge-shaped species with distinct genitalia. Length 4.5 mm.

Vertex scarcely produced, broad, rounded, more than twice as wide between eyes at base as median length. Elytra long and narrow.

Color: Vertex bright yellow with two large round proximal spots at apex. A rather large, black spot just beneath each ocellus next the eye. A broad black band between the anterior portions of the eyes which is bent basally at each end. Pronotum dull brown, black margined anteriorly. Scutellum yellow with the basal angles, median basal spot and a T-shaped mark on the posterior half fused so as to form a heavy black marking, leaving only two yellow spots on the disc and the apical margin pale in color. Elytra black except the broad hyaline costal margin, veins yellow, face bright yellow without markings.

Genitalia: Male plates rather broad at base, convexly rounded to acutely pointed apices.

Holotype male collected at Mexico City, D. F., Mexico, 42 Kilometers south, at an elevation of 10,000 ft., September 5, 1939, by Plummer and DeLong. Allotype female and male paratypes collected at Cruz Blanca, Vera, October 13, 1945, elevation 7000 ft. Female paratypes were also collected at Deserto des Leones, D. F., October 17, 1945, elevation 9000 ft., and Rio Frio, D. F., October 18, 1945, elevation 9500 ft., by Shaw, DeLong, Hershberger and Elliott.

Idiodonus insculptus n, sp.

A broad blunt headed species with distinct dark marks on the anterior portion of the pronotum and scutellum. Length 6 mm.

Vertex broadly rounded, more than two and one-half times as broad as long.

Color: Vertex pale yellow with two elongated spots on margin extending between ocelli and fused so as to leave only a minute white spot at apex, the ends of the band extending beneath ocelli and fused with a spot below ocellus on each side. A broad black band touching the ocelli on each side extends transversely between anterior half of the eyes. This is sometimes interrupted at middle forming a black transverse spot at each eye. Pronotum yellowish, anteriorly, conspicuously marked with black spots, those along anterior margin are fused. The pair at the anterior center of the disc are rounded and are not fused with the other markings, posterior half marked with brownish pigment. Scutellum yellowish, anterior portion of basal angles marked with black spots. Two round black spots on the anterior portion of the disc and a heavy T-shaped mark on the posterior half. Elytra smoky subhyaline except the broad pale costal portion; veins yellow. Face pale yellow heavily marked with black, especially along the sutures, and black arcs of face which are fused on either side next to the clypeus and extend across the face just beneath the vertex.

Genitalia: Female last ventral segment with rather short lateral markings, the posterior margin sloping to a truncate position on median half which is rather deeply narrowly excavated. About one-third the distance to base the caudal margins are rounded to posterior margin. The excavation is broadly dark margined. Male plates triangular, elongate, apices pointed.

Holotype female, allotype male and male and female paratypes collected from pine at La Guarda, D. F., Mexico, (K. 40–43) at an elevation of more than 10,000 ft., September 5, 1939, and October 26, 1941, by Plummer, Good and DeLong.

Idiodonus edentulus n. sp.

A blunt narrow headed species with four conspicuous black spots on vertex. Length 5.5 mm.

Vertex bluntly produced and rounded, twice as broad between eyes at base as median length.

Color: Vertex pale yellow. Disk tinted with orange. A pair of large proximal quadrate black spots at apex. A black spot just beneath each ocellus. A minute brown spot at middle just above apical spots. A large quadrate black spot next each eye above ocellus with an elongated portion extending basally. Pronotum dull brown with a few black markings along the anterior margin. Scutellum yellowish with a modified T-shaped black spot on basal half. Elytra smoky, subhyaline, claval portion and costal margin paler. Veins pale yellow. Face yellow with portions of the arcs rather faint in color.

Genitalia: Female last ventral segment roundedly produced to posterior margin which is broadly, convexly rounded either side of a broad excavation which is narrowed and truncated at apex and extends about one-third the distance to base. Median half of the last ventral segment broadly dark margined.

Holotype female and paratype females collected at Rio Frio, D. F., Mexico, elevation 10300 ft., October 7, 1941, and September 22, 1941, respectively, by Plummer, Caldwell, Good and DeLong.

Idiodonus plummeri n. sp.

Resembling *caldwelli* in general form but with entirely different coloration and genitalia. Length 5 to 5.5 mm.

Vertex produced and bluntly angled, more than one-third wider between eyes at base than median length.

Color: Vertex creamy white with a pair of large black proximal spots at apex. These appear to almost fuse on their inner basal margins. A pair of elongate quadrate spots broadened next to the eye form the ends of an interrupted band between the anterior portions of the eyes. The central portion of the band is orange in color. The curvature of the posterior margins of the spots at apex and the anterior margins of the two quadrate spots give the appearance of portions of two concentric black rings. Pronotum dark brown with a median transverse white band.

The anterior margin is black and there are transverse black markings on the posterior half. Scutellum orange brown on anterior half, white on posterior half except for the triangular black mark on the median portion. Claval suture broadly white, claval veins pale, veins of the corium black, interrupted by white spots. Face creamy white with black sutures and black portions of arcs on either side.

Genitalia: Female last ventral segment rather long with posterior margin slightly produced to form a broad median tooth which is slightly notched at the middle.

Holotype female and paratype female collected at Rio Frio, D. F., Mexico, elevation 10300 ft., October 18, 1941, and September 22, 1941, respectively by Plummer, Good, Caldwell and DeLong. Paratype female from Tres Cumbres, D. F., Mexico, elevation 9100 ft., October 21, 1941 (K-52) collected by Good and DeLong.

Idiodonus latidens n. sp.

Resembling *plummeri* in general appearance but more narrow, with a more produced head, distinct coloration and genitalia. Length 5 mm.

Vertex angularly produced and bluntly pointed, about one-third wider between the eyes than median length.

Color: Vertex white with red flecks, with two round black spots at apex. A pair of short broad transverse spots between anterior portions of eyes. These are located next to each eye and extend about one-half way to the median line. Posterior portion of vertex washed with pale brown. Pronotum darker brown with a median transverse white band which is bordered irregularly with dark brown. Scutellum pale brown on anterior half. Posterior portion creamy yellow with a yellow transverse impressed line at the end of which the black spot extends to the margin either side of apices. Elytra brown, subhyaline, claval suture broadly white, costal margin broadly whitish hyaline, bordered posteriorly by a heavy brown line which extends from base to apex of elytron. Face pale, washed with pale brown, sutures black, traces of black arcs either side.

Genitalia: Female last ventral segment rather short, broadly rounded from lateral margin to posterior margin which is truncated on median half with a narrow excavation extending about one-fourth the distance to base either side of a broad median spatulate process which extends to about the posterior margin. Male plates rather long and narrow, triangular, concavely rounded to pointed apices.

Holotype female, allotype male and male and female paratypes collected at Zitacuaro, Mich., Mexico, elevation 6700 ft., September 29, 1941. Female paratypes from Mexico City, D. F., Mexico, elevation 7500 ft., September 1, 1939; Carapan, Mich., Mexico, elevation 5000 ft., October 2, 1941, were collected by Caldwell, Good, Plummer and DeLong. Paratype male from Chapultepec Hts., D. F., Mexico, elevation 8000 ft., Fenruary 16, 1926 (M. B. 150) collected by Dr. Dampf.

Idiodonus bakeri n. sp.

Resembling *plummeri* in coloration and general appearance but with a more angled vertex. Length 5 mm.

Vertex angled and bluntly pointed, about one-fourth wider between eyes at base than median length.

Color: Vertex white with a pair of large black spots at apex, sloping inwardly above and almost touching. A pair of elongate transverse spots, one just back of ocellus on either side extending one-half of the distance between eyes. The central interrupted portion of the band is a reddish brown color. Pronotum brown with a black spot behind each eye, a transverse band across middle and a marginal narrow band on posterior margin. Scutellum brown on anterior portion, a brownish triangular spot on middle of posterior half, white margined on each side. Elytra brown. Veins white on claval area, claval suture broadly white, costal margin white, veins of corium alternately marked with brown and white. Face white, sutures black, arcs of face either side black.

Genitalia: Female last ventral segment slightly excavated either side of a broad median tooth which is rather short and slightly notched at the middle.

Holotype female collected at Deserto de los Leones, D. F., Mexico, elevation 9200 ft., September 23, 1923, by Dr. A. Dampf. Paratype females from same locality December 9, 1923, and March 29, 1925 (M. B. 116) by Dr. Dampf. Paratype females collected at Deserto des Leones, October 17, 1945, elevation 9500 ft., by DeLong, Hershberger and Elliott; paratype female at Laguna de Zempoala, Mor., (K-10), elevation 8500 ft., by Plummer, Elliott, Hershberger and DeLong.

It is a pleasure to name this species in honor of Dr. A. C. Baker who has assisted the writer in so many ways in the collection and field studies of Mexican leafhoppers.

Idiodonus excavatus n. sp.

Resembling *edentulus* in general appearance but more robust and with definite coloration. Length 5.5 mm.

Vertex bluntly angled, almost twice as broad between eyes at base as median length.

Color: Vertex creamy white tinted with yellow with two round black spots at apex, a smaller semicircular spot convexly rounded anteriorly next each eye, between which is a reddish brown band. Pronotum brown on anterior half. Anterior margin narrowly black. A broad, white, transverse band extends across pronotum just before the posterior brown bordered margin. Scutellum yellow, basal angles orange, a median transverse impressed black line. Elytra pale brown, subhyaline. Veins white, claval suture broadly white, costal margin broadly white, subhyaline. Face yellow, sutures black, a round black spot beneath each ocellus and sutures of the face either side black.

Genitalia: Female last ventral segment with the posterior margin slightly produced forming a broad rounded lobe either side of a broad U-shaped median excavation, extending almost half the distance to the base.

Holotype female and paratype female collected at Zimapan, Hgo., Mexico, elevation 6000 ft., September 26, 1941, by Good, Caldwell and DeLong. Paratype females collected at Rio Frio, D. F., October 10, 1945, elevation 9500 ft., by Hershberger, Elliott and DeLong.

Idiodonus mexicanus n. sp.

Resembling *excavatus* in general appearance but with a blunter vertex and distinct coloration. Length 4.5 mm.

Vertex blunt, about one and one-half times as broad between the eyes at base as median length.

Color: Vertex creamy white with two large round black proximal spots at apex and a rather large spot beneath each ocellus next the eye. A broad, irregular, black, transverse band between the middle of eyes. Pronotum brown, anterior margin broadly black with a rather narrow pale band, bordered anteriorly with brown, just before posterior margin. Scutellum orange brown with a conspicuous T-shaped black mark on the posterior half. Elytra dark brown to black subhyaline, costal area broadly white; veins pale.

Genitalia: Female last ventral segment with short lateral margins, posterior margin broadly convexly rounded forming a rather square excavated notch with a truncated apex one-fourth the distance to base.

Holotype female collected at Deserto de los Leones, D. F., Mexico, elevation 9200 ft., September 23, 1923, by Dr. A. Dampf.

Idiodonus goodi n. sp.

In general appearance resembling *mexicanus* but more narrow with a definite color pattern and distinct genitalia. Length 5 mm.

Vertex scarcely produced, almost parallel margined, almost twice as broad between eyes as median length.

Color: Vertex pale yellow with a pair of round black proximal spots at apex. A smaller spot just beneath each ocellus next the eye, a conspicuous transverse black band enlarged at either end between the anterior margins of the eyes. Pronotum dull grey, black margined anteriorly. Scutellum yellow, a semicircular dark spot in each basal angle, a black cross on the middle.

Elytra grey to smoky, subhyaline, veins pale. Claval veins broadly yellow, costal margin broadly pale, bordered posteriorly by broad brown stripe. Face bright yellow, unmarked.

Genitalia: Female last ventral segment with posterior margin sinuate, forming a broad rounded lobe either side of shallow median notch.

Holotype and paratype females collected at La Guarda, D. F., Mexico, elevation 8500 ft., October 26, 1921, and September 5, 1939, respectively, by Good, Plummer and DeLong.

I take pleasure in naming this species in honor of E. E. Good, whose excellent field work has showed him to be a promising biologist.

Idiodonus clathrus n. sp.

Resembling *insculptus* in general color pattern of the head but more narrow and without markings on the pronotum and with distinct female genitalia. Length 5 mm.

Vertex transverse and almost parallel margined, twice as wide between eyes at base as median length. Scarcely produced.

Color: Vertex creamy white, a pair of elongate transverse spots almost fused at middle, forming a broken transverse band on margin between ocelli. A black spot just beneath ocellus against each eye. A broad irregular band between the anterior portions of the eyes, almost paralleling the broken band on the margin. Pronotum dark brown mottled with black. Scutellum, anterior portion orange brown with a black T-shaped mark on posterior half. Posterior portion white. Elytra smoky subhyaline. Veins mostly brown. Face yellow, sutures black, black arcs on either side.

Genitalia: Female last ventral segment with posterior margin broadly rounded either side of a broad median excavation which is narrowed at apex and extends about one-third the distance to the base. Male plates elongate, triangular. Apices attenuated, long and slender.

Holotype female, allotype male and male paratypes collected at La Guarda, D. F., Mexico, elevation 9800 ft., September 5, 1939, by Plummer and DeLong. Paratype males and females collected at Rio Frio, D. F., Mexico, elevation 10300 ft., October 7, 1941, September 22, 1941, Mt. Popo, Mexico, elevation 11500 ft., September 28, 1941, La Guarda, D. F., Mexico, elevation 8500 ft., October 28, 1941, by Plummer, Caldwell, Good and DeLong. Paratype males and females collected at Rio Frio, October 18, 1945, elevation 9000 ft.; Morelia Rd., at border of Mexico and Michocan, September 28, 1945, elevation 7200 ft., and at Laguna de Zempoala, Mor., October 21, 1945, elevation 9500 ft., by Plummer, Elliott, Hershberger and DeLong.

Idiodonus turpiter n. sp.

Resembling *clathrus* in general form and appearance but with different color markings. Length 5 mm.

Vertex bluntly roundedly produced, twice as wide between the eyes at base as median length.

Color: Vertex white with a pair of transverse spots on margin between the ocelli. These are narrowest at the ocelli and are broadened at median line where they are narrowly separated with white. There is a small black spot beneath ocellus either side. There is a large black somewhat quadrate spot just above each ocellus which replaces the band in *clathrus*. The disc is broadly orange brown. Pronotum dark brown with a pale area in the anterior median portion. Scutellum reddish brown with a median, impressed, transverse black line at each end of which is a white marginal area. Elytra pale brown, subhyaline. Veins pale, face creamy white, sutures black, black arcs on face either side of median line.

Genitalia: Female last ventral segment rounded from lateral margins to a produced posterior margin which is rounded on either side of a broad median excavation almost one-third the distance to base. The excavation is slightly roundedly notched at apex.

Holotype female and paratype females collected at La Guarda, D. F., Mexico, elevation 9800 ft., October 26, 1941. Female paratypes collected at Rio Frio, D. F., Mexico, elevation 10300 ft., September 22, 1941, Mt. Popo, Mexico, elevation 11,000 ft., and Puebla, Pue., Mexico, elevation 8500 ft., October 18, 1941, by Caldwell, Good, Plummer and DeLong. Paratype females collected at Rio Frio, D. F., elevation 9500 ft., October 18, 1945, by DeLong, Hershberger and Elliott.

Idiodonus anademus n. sp.

Resembling *turpiter* in general form and appearance but with distinct markings and female genitalia. Length 4.5 to 5 mm.

Vertex blunt and slightly produced almost twice as broad between the eyes at base as median length.

Color: Vertex pale with two broad transverse spots on margin between ocelli, slightly separated at middle. A quadrate black spot just beneath each ocellus. An angular black spot just above each ocellus. A median black line on disc, basal two-thirds orange brown, basal margin white. Pronotum dark brown with a median longitudinal pale stripe. A small quadrate black spot either side of median line not far from anterior margin. Scutellum orange brown, basal angles darker. A pair of round, black, median spots on anterior portion and a median transverse black line. Elytra brownish, subhyaline. Veins mostly brown alternated with white. Costal margin white. Face creamy white tinted with brown, sutures black and portions of arcs either side of middle, brown.

Genitalia: Female last ventral segment rather short, lateral margins rounded to posterior margin which is broadly, roundedly produced either side of a broad V-shaped median notch which extends about one-fifth the distance to base with a brown spot at apex causing it to appear more deeply notched. Male plates rather broad and convexly rounded to an acutely pointed apex.

Holotype female, allotype male and male and female paratypes collected at La Guarda, D. F., Mexico, elevation 9800 ft., September 5, 1939, by Plummer and DeLong. These were taken from pine.

Idiodonus nigridens n. sp.

Resembling *anademus* in general form and appearance but with different color pattern and distinct genitalia. Length 5 mm.

Vertex bluntly produced, less than twice as wide between eyes as median length.

Color: Vertex white tinted with yellow. A pair of large black spots at apex which are tapered on outer margin and are somewhat transverse. A large black spot just beneath each ocellus and next the eye. A very small black spot just above each ocellus between which there is a broad transverse orange band. Pronotum orange brown with an inverted white T-shaped mark on the posterior portion. Scutellum orange brown, an inconspicuous impressed black transverse line at middle. Elytra brownish hyaline. Veins brown, alternately marked with white. Face yellowish, heavily marked with dark brown or black; sutures are broadly black and the arcs are fused next to the clypeus and are somewhat fused on their inner margins on upper portion of the face.

Genitalia: Female last ventral segment sloping from short lateral margins to form rather narrow produced rounded lobes either side of a broad excavation about one-fifth the distance to base which bears a broad rounded black tooth at middle. The tooth does not extend to the posterior margin of the segment. Male plates small, triangular, elongate, with pointed apices.

Holotype female collected at Cuernavaca, Mor., Mexico, elevation 4900 ft., October 21, 1941, allotype male and paratype males and females from Carapan, Mich., Mexico, elevation 5000 ft., October 2, 1941; Rio Frio, D. F., Mexico, elevation 10300 ft., September 22 and October 18, 1941; Tres Cumbres, D. F., Mexico, elevation 9100 ft., collected by Plummer, Caldwell, Good and DeLong, and Mexico City, D. F., Mexico, elevation 7500 ft., September 2, 1937, (M. F. 6189), collected in pine forest by Dr. A. Dampf. Paratype females collected at Rio Frio, October 18, 1945, elevation 9000 ft., by Hershberger, Elliott and DeLong.

Idiodonus incidus n. sp.

Resembling *nigridens* somewhat in general form but with entirely different coloration and female genitalia. Length 4.5 mm.

Vertex produced and bluntly angled, more than twice as broad between eyes at base as median length.

Color: Vertex with the marginal area white. The posterior two-thirds reddish brown with two round black proximal spots on apex and a black spot about the same size just above each ocellus. The dark coloration on the posterior portion extends from the line connecting these

two spots. Pronotum orange brown unmarked. Scutellum orange brown with an inconspicuous black transverse line on the middle, at each end of which is a small triangular white marginal spot. Elytra smoky subhyaline, the anterior end of claval veins white and the veins on the posterior part of the elytra paler. Face creamy white, sutures and dark arcs on either side of the face, black.

Genitalia: Female last ventral segment with posterior margin broadly roundedly convexly produced from base with a minute U-shaped notch at middle.

Holotype female collected at La Guarda, D. F., Mexico, elevation 8500 ft., September 5, 1939, by Plummer and DeLong. Paratype females collected at Laguna de Zempoala, October 21, 1945, elevation 10,000 ft., in pine and fir forest by Plummer, DeLong, Hershberger and Elliott.

Idiodonus graeculus (Ball)

Thamnotettix graeculus Ball. Can Ent. 33 : 6, 1901.

A blunt headed species without markings on vertex or pronotum. Length 5–5.5 mm.

Vertex bluntly angled, more than twice as wide between eyes as median length.

Color: Vertex, pronotum, scutellum and face bright canary yellow, the disk of pronotum slightly tinged with brown, basal angles of scutellum darker. Elytra brownish subhyaline with spots of milky white coloration especially white areolar spots along the commissural line and clavus.

Genitalia: Female last ventral segment with the lateral angles rounded, between which the posterior margin is deeply excavated halfway to the base at the apex of which there is a spatulate process produced to the length of the lateral angles. Male plates rather long, triangular, with apices acutely pointed.

One specimen was collected at Saltillo, Coah., Mexico, elevation 7000 ft., September 23, 1931, by Good, Caldwell and DeLong. This is the only record that has been obtained to date for this species in Mexico.

Subgenus Angulanus nov.

As compared with Idiodonus the vertex is bluntly angled and is angled with the face. In *Idiodonus* the vertex is rounded to the face. The first apical cell of the elytron is large and about as wide as long. The first anteapical is triangular and about half as long as the second anteapical. The apex of the first anteapical is oblique and does not extend as far apically as the apex of the second anteapical. The first anteapical tapers to a pointed anterior end and partially lies in the concavity formed by the constriction of the second anteapical on its apical half. There is only one cross nervure on the corium.

Genotype *Idiodonus incisurus* n. sp.

Idiodonus incisurus n. sp.

Somewhat resembling *graeculus* in general appearance but with a more produced vertex which is flattened at margin and with a different color pattern. Length 5 mm.

Vertex roundedly produced, less than twice as wide between eyes at base as median length.

Color: The face is bright yellow, unmarked, color extending over margin to vertex with a row of six somewhat fused brown spots just above margin. The central portion of disc is dark brown just posterior to this band except the longitudinal pale line at middle. A pale brown spot in each basal angle next the eye. Pronotum appearing brownish due to the mottled pigment throughout. Scutellum bright yellow, basal angles darker. Elytra pale subhyaline with spots of fuscus and veins dark brown. The color of the wings gives it a milky white appearance.

Genitalia: Female last ventral segment roundedly produced from the lateral margins to form the posterior margin which is broadly, convexly rounded either side of a median rather broad V-shaped notch extending about one-sixth of the distance to base. Male plates elongate, triangular, margins almost straight, apices pointed.

Holotype female, allotype male and paratype males collected at La Guarda, D. F., Mexico, elevation 8500 ft., September 5, 1939, by Plummer and DeLong. A series of male and female paratypes were collected at Tepotzlan, Mor., Mexico, September 11, 1941, by Good, Plummer, Caldwell and DeLong.

FURTHER STUDIES ON THE LIFE HISTORY AND DISTRIBUTION OF EUBRANCHIPUS VERNALIS (VERRILL)[1]

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During the winter and spring seasons of 1943 and 1944, field studies on the distribution and life history of the fairy shrimp *Eubranchipus vernalis* (Verrill) in northeastern Ohio were continued. Results of the studies made during the two previous years have been published earlier (Dexter and Sheary 1943; Dexter 1943b). Additional data have been secured on the geographic and seasonal distribution, limits of temperature and hydrogen ion concentration, fluctuations of abundance, new appearances and disappearances, sex ratio, and color characteristics of *E. vernalis*. Also, information on the life history of this species has been obtained by a weekly study of one pond over a period of several months each year and by observations of laboratory cultures of this fairy shrimp.

REVIEW OF FIELD COLLECTIONS. PORTAGE, SUMMIT, AND STARK COUNTIES—1943

During the third consecutive year of this study (1943), 61 pools and ponds in Portage, Summit, and Stark Counties, northeastern Ohio, were examined, including all of those from which any records of fairy shrimps had been known previously. Fifty-eight pools were restudied and three new stations were added. Because of the war-time restrictions on travel, it was necessary to drop 59 stations which had been included in the annual survey. Five others had dried out by the time they were reached, and many pools did not contain as much water as had been found in previous years. Table I gives a summary of the field collections for each year, and Figure 1 shows the location of all positive records.

The first specimens collected in the winter of 1943 were taken on February 4. These were smaller than those first collected in previous years, but the collection of February 11 compared very favorably in size with specimens collected from the same pond (Pond P7) on March 15, 1942, which in turn were comparable in development to those collected a week earlier the previous year. The last collection of the original population from this pond in 1943 was made on April 1. Five days later the pool dried up. The last collection there in 1942 was made on April 23, at which time the pond had become very nearly dry. A second population developed in this pond after refilling on April 13, 1943. Small numbers of *E. vernalis* were collected between May 10–25. Only three ponds (Ponds P43, S1, C2) had more abundant specimens of *E. vernalis* in 1943 than in 1942, while twelve ponds (P17, P18, P79, S3, S5, S12, S18, C6, C7, C9, C10, C12) were found to contain a smaller population in 1943 than during the preceding year.

No species of the anostracan phyllopods was collected in 1943 other than *E. vernalis*. *Pristicephalus bundyi*, which had been collected in one pool in 1942, was not found again. Because of the much smaller population of fairy shrimps in that pool and the limitation of time for collecting, only 31 specimens were taken. Had a more thorough sampling been made, it might have disclosed the presence of *P. bundyi* for another year.

[1]Acknowledgment is made to those persons who have kindly contributed records as indicated in the paper, especially to Mr. Charles H. Kuehnle, who has assisted the writer on collecting trips in Stark County, and to Dr. N. T. Mattox, who has read the manuscript. Portions of this paper have been read before the Zoology Section of the Ohio Academy of Science and before the Ecological Society of America.

A total of 24 stations was found inhabited by *E. vernalis* during the spring of 1943 (7 in Portage, 7 in Summit, and 10 in Stark Counties). Altogether 30 pools have been known to contain this species at some time during the period between 1941 and 1943.

REVIEW OF FIELD COLLECTIONS. PORTAGE, SUMMIT, AND STARK COUNTIES—1944

During the season of 1944, fifty-five of the established stations and five new pools were investigated (35 in Portage, 12 in Summit, 13 in Stark Counties). Again, all pools from which any collections of fairy shrimps had been made in the past were restudied. During the fall of 1943 and the winter of 1944, most of the temporary pool depressions contained no water, and for the most part did not fill with water until the first week of March. The month of December, 1943, was the driest since 1925. The spring rains, however, filled the pools. (See Table I and Figure 1 for collecting data).

TABLE I

FLUCTUATIONS OF POPULATIONS OF THE FAIRY SHRIMP, *Eubranchipus vernalis* IN THREE COUNTIES OF NORTHEASTERN OHIO

STATIONS	1940	1941	1942	1943	1944
P7, P18, P79, S1*, S5, S11, S14, C7* (*S1, C7, also + in 1940)		+	+	+	+
S18, C2, C3, C6, C9, C11, C12		–	+	+	+
P88, P89, C13		–	–	+	+
P91, P92, C14		–	–	–	+
P17, P43, S12		0	+	+	+
P40, P55, P58		0	0	0	+
C8	+	+	0	+	+
P30, P50		+	0	0	+
P80		+	+	0	+
S2	+	0	+	0	+
S4		+	+	0	0
S3	+	+	+	+	0
C10		–	+	+	0
P37		+	0	0	0
P1, P8, P12, P14, P22, P42, P47, P48, P49, P54, P66, P68, P69, S7, S8, S13		0	0	0	0

+=*E. vernalis;* 0=No fairy shrimps; –=Not Studied.

Out of a grand total of 127 pools studied in the three counties over a period of four years, thirty-six have contained *E. vernalis* at one time or another, and thirty-two of these had records in 1944. This year was a very favorable year for the fairy shrimps. Eleven of the pools (P17, P79, P89, S1, S11, S18, C2, C7, C8, C12, C13) had definitely more abundant populations than they had had during the preceding year, while only four (P7, S14, C6, C9) had populations that were

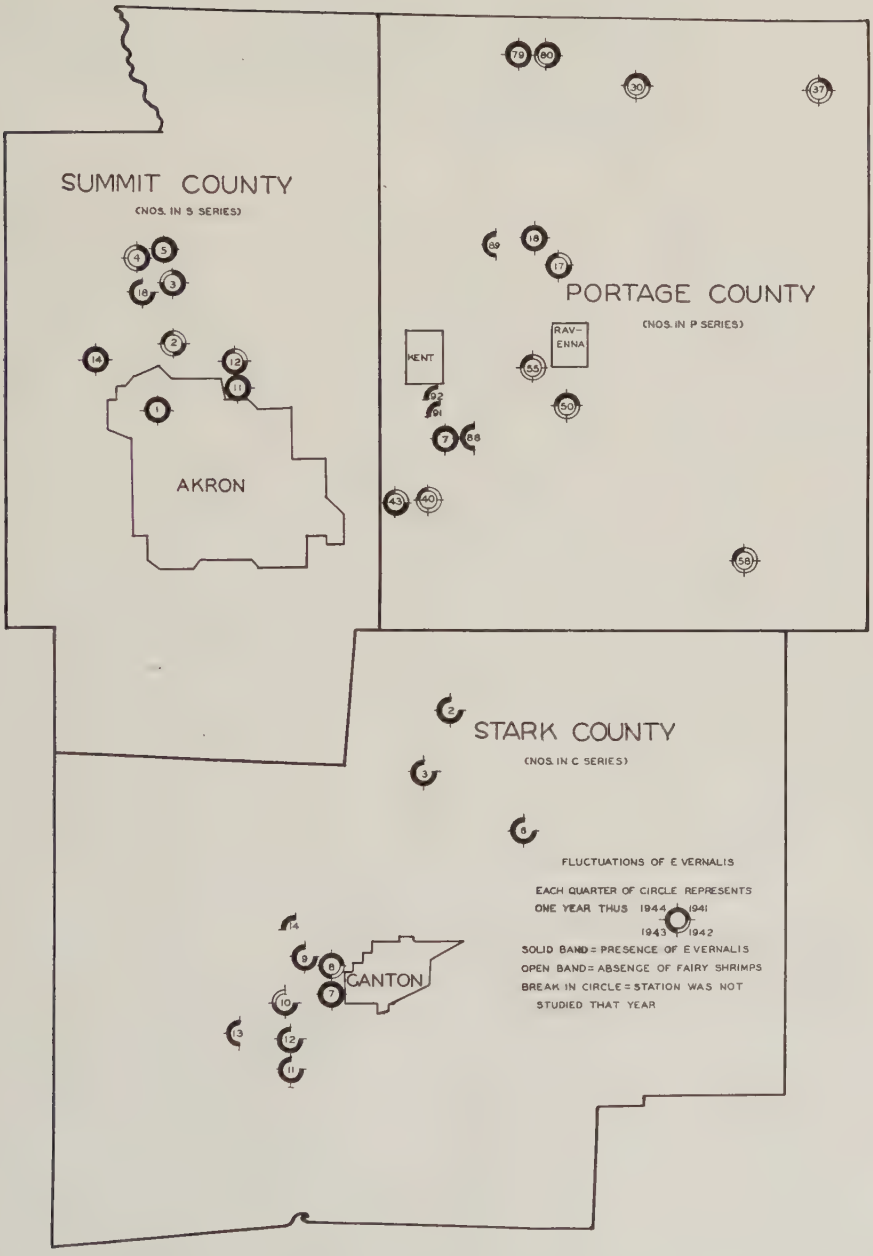

FIG. 1. Map of Portage, Summit and Stark counties, Ohio, showing the locations from which *Eubranchipus vernalis* has been collected.

less abundant in 1944 than in 1943. Nearly all of the observed annual changes are of such a magnitude as to be easily detected. Sixteen stations have had no records of fairy shrimps for four consecutive years, six others, for three years; and two of the new stations did not contain specimens. The 1944 populations were about six weeks later in appearing than during the previous year. Specimens collected on March 25, 1944, were about equal in size and development to those collected on March 4, 1943. Egg sacs were first found developed in the season of 1944 on April 2, on specimens collected at Canton.

OBSERVATIONS ON THE LIFE HISTORY AND ECOLOGICAL RELATIONS OF E. VERNALIS

When specimens were first collected on February 4, 1943, they were already 4.65 mm. in length, which fact was rather unexpected because of the long, cold winter weather which preceded this date. A sample was collected each week after February 4, until the pool (P7, near Brimfield) dried up on April 6. A rather uniform sample of ten individuals was measured from the collection of each week. Table II gives the measurements of total length which were made from the anterior margin of the head to the extremity of the caudal furca, but not including the filaments. Data are also presented on the temperature and hydrogen ion concentration of the pool on the dates of collecting. The rate of growth was erratic. Egg sacs first appeared on the females in this pond on March 25. The average maximum size attained was 15.44 mm. which was reached by April 1. Comparison should be made between these data and the growth of *E. serratus* studied in a pond of east central Illinois (Dexter and Ferguson, 1943). As nearly as could be determined only one generation of *E. vernalis* was present, and the samples were for the most part very nearly uniform in size on any one day.

The week following the drying out of Pond P7, it filled up again from a series of snow squalls and rainy spells. On April 17, 1943, and again one week later, a plankton sample was taken throughout this pasture pool, but neither time were the nauplii or metamauplii of *E. vernalis* found. Great quantities of copepods and ostracods and a number of insect larvae had hatched and given rise to a very rich plankton population. It was as rich in species and in quantity as the first plankton sample which had been taken on February 4. On May 10, however, three immature, female fairy shrimps which averaged 10.7 mm. in length were collected. Nine days later two males were taken in the net after a careful search, and on May 25 one male and two females were found. Those of the last collection were of the characteristic colors for fully developed, mature individuals, and were the largest specimens seen during that season, averaging 25.8 mm. in length.

While it may be possible that this second population came from eggs laid by the first generation, which lived in the pool during the preceding months, it is more likely that it came from eggs which had been deposited during some earlier year. Weaver (1943) has shown experimentally that the eggs of *E. vernalis* can hatch without being frozen, contrary to a common belief that freezing is necessary before hatching will take place. However, Avery (1939) and Weaver (ibid.) found that a considerable rest period seems to be required before hatching will occur. Whether the eggs are dried or frozen or not some of them will hatch after a lapse of time. Weaver found an interval of twelve days between the "shock" of drying or freezing and the hatching of the eggs. The number of individuals which he succeeded in hatching under various controlled conditions in regard to freezing and drying was not great, and in no case did all of the eggs hatch. Contrary to the work of Weaver, Castle (1938) observed that some eggs of *E. vernalis* hatched in an aquarium without having been dried, and Avery (1939) succeeded in hatching eggs which had never been dried, but had had a resting period of one year. His experimentally dried eggs failed to hatch. Mathias (1937) had stated earlier that desiccation is not necessary for the development of phyllopod eggs.

TABLE II

COMPARISON OF LIFE HISTORY OF *Eubranchipus vernalis* IN POND P7 IN 1943 AND IN 1944

1943						1944				
Date (both years)	°C	pH	MM in Length	Amt. of Growth in MM	Notes	°C	pH	MM in Length	Amt. of Growth in MM	Notes
Feb. 4	3.0	5.9	4.65	.....	First collection of season; under ice: pool not full; specimens orange-pink.					
Feb. 11	0.0	5.9	4.83	0.18	Under ice.					
Feb. 18	0.5	6.0	6.25	1.42	Under ice.					
Feb. 25	4.5	6.0	6.87	0.62	Under ice.					
Mar. 4	0.5	6.1	8.31	1.44	Under ice.					
Mar. 11	1.0	6.3	9.03	0.72	Under ice.	2.0	5.3	2.53	.....	First collection of season; under ice.
Mar. 18	9.0	6.3	11.76	2.73	Males light green; females bluish-gray.	5.5	5.9	5.11	2.58	Pond about half full.
Mar. 25	11.5	6.4	12.43	0.67	Egg sacs developing.	16.6	6.15	8.56	3.45	
April 1	21.0	6.4	15.44	3.01	Pond half dried.	4.7	6.1	11.92	3.36	Second antennae of males well developed.
April 8	.....	.....	.....	.....	Pond dried up April 6; refilled April 13.	8.8	5.9	14.40	2.48	Pond nearly dry; egg sacs developing; eggs small.
April 15	.....	.....	.....	.....	.....	10.5	6.1	16.75	2.35	Pond refilled to about half full; males greenish; females bluish-gray; egg sacs large.
April 22	.....	.....	.....	.....	.....	13.5	6.1	19.00	2.25	All mature except one specimen — probably a late hatching.
April 29	.....	.....	.....	.....	.....	.....	.....	.....	.....	Pond dried out.
May 10	.....	.....	10.7	.....	Pond nearly full; 3 immature females collected; colorless.					
May 19	21.0	6.4	22.5	11.8	2 males collected; colorless.					
May 25	17.5	6.8	25.8	3.3	1 male, light green; 2 females, bluish-gray. Last collection.					

Weaver did not succeed in hatching eggs which had not been allowed to dry, and had been kept in water for nine months. The writer has attempted to hatch eggs of fairy shrimps by drying, freezing, and the prevention of drying and freezing, but without success. In these experiments, however, small numbers of eggs were used, and it is apparent that the factors regulating the hatching of eggs of fairy shrimps are little understood. Weaver concluded that drying, freezing, and a long rest period are usual before hatching occurs. He believes that drying is important and that freezing seems to induce hatching.

From the experiments of Avery (1939) and Weaver (1943) and their finding that a period of rest is required before hatching will take place regardless of environmental factors, and from the results of field observations reported here, especially of sudden appearances and disappearances of populations of considerable size, the following interpretation first developed by Hesse (1924) from observations reported from Europe and Africa has been adopted. The eggs of *E. vernalis* are without doubt widely distributed in the soil of depressions and dried-out pools. Probably myriads of such places contain some eggs which have been present over varying lengths of time. The question of how fairy shrimps or their eggs are introduced into these temporary pools is at the present time largely a matter of conjecture. Mathias (1937) in his monograph on the biology of the phyllopods explains the dissemination of the eggs as being carried by the wind, and on amphibians, water birds, and other animals which travel from pool to pool. He also states that phyllopod eggs pass through the digestive tracts of amphibians, birds, and possibly mammals, and still remain viable. Some years, when conditions are favorable, many of these latent eggs which have been scattered about will hatch in the spring when the depressions are filled by melting snow and ice. Other years they may fail to hatch in any certain pool, but remain viable for another season. Some eggs may not hatch for a number of years. The radical changes from year to year are probably the result of a successful hatching or a failure to hatch rather than being a new introduction or a total elimination of the species since it was last recorded. This explanation seems the most plausible in view of what is known of the life history of the species and the sporadic nature of its geographic and seasonal occurrence.

It has been noted that sometimes fairy shrimps do not appear in deep pools as early as they do in shallow water. Specimens of *E. vernalis* collected from pond P88 on March 18, 1943, for example, were only 4.05 mm. in length. The same day, specimens from Pond P7 nearby had an average length of 11.76 mm. Those from the deeper pool were at that time approximately the size of specimens collected from station P7 six weeks earlier. After the fairy shrimps from the deeper pool reached maturity they averaged only 13.8 mm. in length (May 5, 1943).

In the season of 1944 most of the pools did not fill up until March 6. *E. vernalis* was not found in Pond P7 until March 11. At that time the fairy shrimps were only 2.53 mm. in length, while they were 9.03 mm. on that date of the preceding year and had been active in the water for some five weeks preceding that time. However, the individuals of the 1944 population grew rapidly, reached maturity in a short time, and attained great size. During the development of the 1944 population, the pond water was somewhat warmer than during the period of development of fairy shrimps of the same size in the 1943 population. This difference explains without question the different rates of development and maturity. The fairy shrimps were present in Pond P7 in 1944 until it dried out sometime between April 22 and 29.

During the month of March and early in April of 1944 pond P88 for some reason failed to fill with water. No more than an inch or two collected in the lowest portion of the trough, and much of that was in the form of scattered puddles. A plankton sample taken from these shallow puddles on March 18 contained two

metanauplii of fairy shrimps. No others were found in earlier or later samples. On April 11 a rainstorm of 1.49 inches filled this pond. On April 22 a large population of fairy shrimps was found in the water. They grew and matured rapidly in the warm water (see Table III). The eggs were developing on the females within two weeks after hatching, and the population completed its entire existence as free-swimming organisms in little more than thirty-two days. The population disappeared after May 13. Water remained in the pond for several weeks longer, but had an afternoon temperature of over 21 degrees C. which seems to be the limit beyond which *E. vernalis* does not live for long.

TABLE III

DEVELOPMENT OF *Eubranchipus vernalis* IN POND P88, SEASON OF 1944

Date	°C	pH	MM in Length	Amt. of Growth in MM	Notes
April 22	.....	.....	4.20	.....	Pond filled April 11; late hatching; specimens orange-pink.
April 29	15.0	5.8	12.90	8.7	Orange-pink in color; egg sacs developing.
May 6	14.0	5.5	15.35	2.45	Males light green; females bluish-gray; egg sacs well developed.
May 13	21.1	5.6	16.30	0.95	Last collection.
May 20	21.7	5.9	.....	.....	*E. vernalis* not present; pond still contained 1.5 ft. water.

E. vernalis has been found in a range of water temperature from 0° to 21° C. Individuals kept in aquaria in the laboratory with an average water temperature of around 20° C. lived on an average of 6.5 days. The longest surviving individual of each culture averaged 16.5 days. The longest surviving of any one individual was 30 days. This species has been found in a pH range from 5.3 to 7.6 with instances for almost every graduation between these limits. Mathias (1937) reported that phyllopods in general prefer alkaline water and do not withstand acid water. The experience of the writer has been that *E. vernalis* has a wide range of tolerance and probably could live in hydrogen ion concentrations found in most natural pools of water whether acid or alkaline.

It has been observed that on cloudy days fairy shrimps have a tendency to remain at or near the bottom while on sunny days they swim near the surface of the pools.

It is commonly believed and often repeated in textbooks that the first generation of fairy shrimps consists entirely of females which reproduce parthenogenetically by means of "summer eggs." Later in the season, it is believed by some, males are produced which fertilize the winter eggs. These presumably produce the first generation of females the following season. A number of specimens of *E. vernalis* collected early in the season before any were mature and kept in an aquarium developed into males, hence they must have hatched from "winter" eggs. Also, many males were collected in the pond before mature females had developed. In addition, egg sacs were not fully formed in the specimens of Pond P7 until 5 days before the pond dried out. It is evident that for this species the males hatch from winter eggs, and sometimes, at least, there is but a single generation in a season.

In another pond nearby, however, it seems quite possible that more than one generation was produced in one season. This pond (Station P88) is a deep depression which does not dry out completely every year, although usually it does. It has steep banks, but they are at least partly exposed during the summer months. Specimens collected from this pond on March 18, 1943, were only as much devel-

oped as those collected in the shallow water of Pond P7 on February 11. However, the population in Pond P88 continued until May 10, some five weeks after the first population in Pond P7 disappeared. During April, specimens of all sizes and in all stages of development could be collected at the same time from the deep pond. A number of other pools, especially deep ones, contained specimens in various stages of development suggesting that more than one generation might be present. Some pools had two distinct size groups. Pond P43, for example, had two distinct size groups collected under ice as early as March 21. Whether these represent two generations (one group was sexually mature) or whether they simply hatched at different times is not known. Mathias (1937) claims that two kinds of eggs are produced—those which hatch immediately, and resistant eggs which can withstand desiccation for a number of years. The writer has not been able to obtain a second generation of fairy shrimps in an aquarium.

Avery (1939) reported collecting *E. vernalis* from a body of water not known to be dry over a period of seven years. From this fact and from the results of hatching experiments he concluded that the common belief that this shrimp occurs only in temporary springtime pools does not agree with the evidence. An abstract of his paper (Biological Abstracts 15: 3340) conveys a false impression through the unfortunate omission of the word "only" in the above statement. As the writer has already pointed out, (Dexter, 1943a) nearly all records of fresh-water fairy shrimps are from temporary spring pools, although a few records are known as the one reported by Avery where fairy shrimps are found in ponds which do not dry out entirely, but which have a dry margin during the summer months. Shelford (1937) has quoted an observation made by Child in the Chicago region that fairy shrimps sometimes appear in ponds which seldom dry out, but which after a long period of drought do dry out. The following season, after refilling with water, the pond is found to contain fairy shrimps. It may be that other records of fairy shrimps found in ordinarily permanent ponds can be explained by the same situation. In such ponds, fairy shrimps might be an important item of food for fishes, as it is sometimes mentioned in zoological literature. Usually, however, fishes are not found in the same community with fairy shrimps.

SEX RATIO

Textbooks and manuals often state that the males of fairy shrimps are relatively scarce. Very little is to be found in original literature concerning the sex ratio. Weaver (1943) found five females to one male on March 18, 1940, but later in the season the proportion of males increased as the shrimps got larger. After March 30 the males began to disappear. In regard to this problem, samples have been taken by the writer from a variety of ponds and over a period of time to determine the proportion of sexes as found for *E. vernalis*. A sample of 145 specimens collected in the spring of 1941 had a ratio of 55 males: 90 females (1 : 1.6). Of 240 specimens collected during the following spring a ratio of 100 males: 140 females (1 : 1.4) was found. On March 3, 1943, 100 specimens taken from Pond P7 showed a ratio of 32 males: 68 females (1 : 2.1). One week later another sample of 100 removed from the same pond had nearly the same ratio—35 males: 65 females (1 : 1.9). A mixed sample of 141 specimens taken from various pools during the same spring had a ratio of 55 : 86 (1 : 1.6). A similar sample of 364 individuals collected in 1944 also had a ratio of 1 : 1.6. In contrast to these a sample of 122 individuals collected from several pools in Stark County on April 3, 1943, showed the reverse trend with a ratio of 80 males: 42 females (1 : 0.5). This is the only time the writer has collected a sizable sample in which the males predominated. The average of all of these (1212 individuals) gives a ratio of 1 male: 1.5 females. It is clearly evident that for *E. vernalis* in the years and regions covered in this study, the males have been much more abundant than is commonly

believed. Contrary to the finding of Weaver, the writer has not observed the sex ratio to change during the season.

COLOR

While all of the specimens of *E. vernalis* of comparable age and development collected from the same pool have been uniform in color, the color does change as the individuals mature (Dexter 1943b). In the report cited, observations of the change in color were made by successive collections from the same pools. During the spring of 1943 this observation was confirmed by individual specimens kept in culture in the laboratory. On February 18, 4 specimens of the typical orange-pink or salmon color were placed in an aquarium. On March 4 this color began to fade in a surviving male specimen and by the next day it was light green in color as reported earlier for mature males of *E. vernalis*. The specimens in the pond from which the collection was made were still orange-pink at this date. Another sample was taken at this time and also placed in an aquarium. Six days later the orange-pink color began to fade and the egg sacs developed. On March 23 the females were entirely bluish-gray in color as reported earlier for the mature females. Four days later they turned the same cream color observed in old specimens of *E. serratus* when kept in culture for several days beyond the time of maturation. A number of females collected on March 11, 1943, developed egg sacs and turned bluish-gray on March 18. On this day, the largest female specimens in the pond were just developing the color characteristic of the adults, while the majority of the pond specimens were still orange-pink.

In the season of 1943 a population of *E. vernalis* was discovered which had a most unusual color. On April 3 the writer with Mr. Charles H. Kuehnle, collected a sample of *E. vernalis* from a shallow swamp-pond near Canton, all of the specimens of which were light blue in color. Not only those collected, but all of the individuals seen swimming about in the water had the same characteristic coloring. This pigment was found throughout the body, but was particularly noticeable in the head and on the tips of the appendages. The writer had never before seen a fairy shrimp population of such a color. It was suggested by Dr. C. E. Venard that the light bluish color might be caused by blue-green algae attached to the cuticle of the fairy shrimps. A sample from the Canton pond was sent to Dr. C. E. Taft for examination, but no algae were found. Dr. Taft reported that he has seen fairy shrimps with algae, usually of the genus *Characium*, attached to the animals, but he knows of no record where blue-green algae have been similarly found. The following year Mr. Kuehnle and the writer collected again from this swamp-pond. On April 2, 1944, all of the specimens found were of the usual orange-pink or salmon color, and not a single one had the peculiar light blue color found the preceding year. On April 15 Mr. Kuehnle made another collection from this location and the specimens were still normal and uniform in color. It is possible that some chemical property of the swamp water during the season of 1943 was responsible for the unique coloring of the shrimps that season.

ADDITIONAL RECORDS OF ANOSTRACAN PHYLLOPODS COLLECTED IN OHIO

In addition to the records of this survey and the references which have been cited (see Dexter and Sheary, 1943; Dexter, 1943b), a number of collections and records from Ohio have come to the attention of the writer which are presented in Table IV. Specimens from the following collectors have been identified by the writer: Vickers, Azary, Chiavetta, Surrarrer, Kuehnle, Wilson, Geist, Venard and Gerberich, Blaydes, and Rice. Dr. N. T. Mattox identified those collected by Clark as well as his own specimens. Dr. R. M. Bond identified those collected at Oberlin. The following made their own determinations: Linscheid, Hazard, Dreyer, Stehr, and Gier. All of the specimens which have been identified to

TABLE IV

ADDITIONAL RECORDS OF ANOSTRACAN PHYLLOPODS COLLECTED IN OHIO

County	Collector	Location	Species	Notes
Mahoning	Ernest Vickers, Park Naturalist, Mill Creek Park	Mill Creek Park, Youngstown	*E. vernalis*	Fairy shrimps have been observed at various times over many years. One collection only, without date, has been saved.
Lake	Kenneth Chiavetta	North Chagrin Reservation	Unknown	Abundant specimens collected from single pool on April 12, 1942. None found in several other nearby pools. Specimens disintegrated before determination could be made.
	Ross Azary	Eastern edge of Painesville	*E. vernalis*	Abundant specimens collected from a pasture pool on April 8, 1944. None found in two nearby pools.
Cuyahoga	Alfred G. Linscheid, Shaker Heights Schools	Warrensville Heights	*E. vernalis*	Abundant specimens found in March of each year between 1931 and 1943 in an extensive swamp-pond opposite the Warrensville Farm buildings.
	Kenneth Chiavetta	Fairview	*E. vernalis*	Specimens collected on April 20, 1942, from a temporary pool.
	Thomas C. Surrarrer, Baldwin-Wallace Col.	Berea	*E. vernalis*	Specimens collected about April 1, 1930, from a pool 1,000 yards from Biology Laboratory.
		Rocky River Reservation	*E. vernalis*	Specimens collected about May 10, 1941, from a temporary pool in woods just beyond junction of the East and West Branches of Rocky River.
Lorain	Members of Biology Dept., Oberlin College	Oberlin	*E. vernalis*	Collections have been made from many pools over many years time, but especially "Cemetery Pond" which Dr. Hope Hibbard says has had specimens every year since first examined.
Wayne	Members of Biology Dept., College of Wooster	Wooster	Unknown	Fairy shrimps have been collected every year from pools near Wooster for a number of years. Specimens have not been preserved. (Information from Dr. R. V. Bangham and Dr. W. P. Spencer.)
	James Anderson	Wooster	Unknown	Some years ago his daughter collected from a pool which has since been filled in road construction.
Richland	Mariel J. Aberle, Mansfield Senior High School	Mansfield	Unknown	Fairy shrimps found just once in Mansfield area. A collection was made in about 1929 at southern edge of city. Return visits year after year failed to find them again. Later, pond was drained and a road bed was made there. Other pools examined have never contained specimens.
Crawford	Charles H. Kuehnle, Lincoln High School, Canton	Bucyrus	*E. vernalis*	Of 8 pools examined on April 9, 1944, 6 contained *E. vernalis*. Specimens in a flooded, cultivated field were very abundant; in one pasture pool they were common; in three others fairly common; and in one, occasional specimens were found.
Marion	Thomas D. Bain, Harding High School, Marion	Marion	Unknown	Fairy shrimps have been collected for a number of years in temporary woodland-pasture pools. In some pools they have been abundant in the early spring.

Seneca	Ira T. Wilson, Heidelburg College, Tiffin	Tiffin	*E. vernalis*	Great abundance of *E. vernalis* was found in some woodland pools 1½ miles northeast of Tiffin in March of either 1924 or 1925. Collections were made just as ice began to break up.
Wood	Edwin L. Moseley, Bowling Green State University		Unknown	Fairy shrimps have been collected in early spring months in various parts of Wood County over a period of years.
	C. H. Otis, Bowling Green State Univ.	Weston, Portage, Scotch Ridge, Pemberville, Bowling Green	Unknown	Preceding 1943, collections of fairy shrimps were made every spring for a number of years in many pasture pools in the county, but especially in Weston Cemetery Pond. None has been collected in recent years because of dry seasons and travel restrictions. One pond near Pemberville has been drained.
Lucas	Archie N. Solberg, University of Toledo	Ottawa Hills Village	Unknown	Fairly common specimens have been collected for several years from a single pond.
Paulding	Clarence F. Clark, Ohio Div. of Conser. and Nat. Resources	Brown Township	*E. vernalis*	Two collections from hog wallows were made on April 15, 1937.
		Auglaize Township	*E. vernalis*	One collection from a Beech-Maple woodland pool was made on May 1, 1939.
Mercer	Clarence F. Clark	Franklin Township	*E. vernalis*	Specimens collected on April 2, 1942, in a temporary woodland pool.
Auglaize	Clarence F. Clark	St. Marys, Washington and Moulton Townships	*E. vernalis*	Twelve pools of various types—roadside, woodland, pasture pools, ditches, and hog wallows—were found inhabited by *E. vernalis* during March and April of 1942.
		Logan Township	*E. vernalis*	Specimens were collected from a roadside pool on April 1, 1944.
				The first known record of *E. vernalis* from Auglaize County is a locality record cited by Daday (1910) for Wapakoneta.
Shelby	Clarence F. Clark	McLean Township	*E. vernalis*	Two woodland pools were found inhabited by *E. vernalis* on April 24 and 25, 1942.
Logan	Donald E. Geist, Bellefontaine High School	Bellefontaine	*E. vernalis*	Abundant fairy shrimps were found in a temporary pool 1½ miles south of Bellefontaine on April 1, 1937. About a week later not a single specimen could be found. Later that year the pool was made into a corn field.
Montgomery	Charles A. Dambach, Ohio State University	Dayton	Unknown	Abundant fairy shrimps in a series of temporary pasture pools four miles east of Dayton were collected in early April of 1939. The specimens were lost through poor preservation before identification could be made.
Warren	Norman T. Mattox, Miami University	Fort Ancient	*E. vernalis*	On April 17, 1940, and again in April of 1941, *E. vernalis* was collected from temporary pools on top of the ridge inside the old earthen-works.
	Frank O. Hazard, Wilmington College	Fort Ancient	*E. vernalis*	A collection was made on April 11, 1944, at the same location as above.
Clinton	Frank O. Hazard	Clarksville	*E. vernalis*	Many collections have been made from pools in a pin oak swamp-forest on an upland flat over a period of years.

TABLE IV—(*Continued*)

County	Collector	Location	Species	Notes
Clermont	William L. Dreyer, Univ. of Cincinnati	Goshen	*E. vernalis*	A collection was made on March 6, 1942, from the same pool from which collections were made by Ward (1940) in 1937 and 1938.
Franklin	Carl E. Venard and John B. Gerberich, Ohio State University	Columbus	*E. vernalis*	Collections were made from 8 pools in the "dyke area" of Columbus in the spring months of 1942–1944. They were common each year.
	Glenn W. Blaydes, Ohio State University	Worthington and Columbus	*E. vernalis*	Observations and collections have been made from 3 pools over a number of years. Fairy shrimps were present every year, and collections were made as follows: On March 3, 1936, on Route 161 east of Worthington; on March 19, 1938, and April 16, 1944, from two pools on Cooke Road north of Columbus. Abundant specimens have been found in all three pools.
Delaware	Members of Zoology Dept., Ohio Wesleyan University	Delaware	*E. vernalis*	Dr. E. L. Rice made a collection of *E. vernalis* in 1911. Burton (1916) made 7 collections between March 3 and April 13 from a pool northwest of Delaware. Hooker (1938) made 16 collections between January 6 and April 15 from the same pool. Both of these list identification as Chirocephalus, which is probably incorrect. Dr. Rice has collected fairy shrimps from the same pool and from another nearby; also from 2 swamp pools south and southeast of Delaware. Members of the department have collected fairy shrimps for many years from the above pools. (Information from Dr. W. F. Hahnert.)
Central Ohio (Portions of Franklin, Delaware, Licking, Knox, Morrow Cos.)	Lawrence E. Hicks, Ohio State University	A belt some 10 miles wide between Worthington and Mt. Vernon	Unknown	Between 1928–1934, some 600 pools were examined for Algae. Approximately 40 were found inhabited by fairy shrimps.
Hocking	J. Arthur Herrick, Kent State University	Sugar Grove Region	Unknown	On April 4, 1942, fairy shrimps were observed in a single pool in which they were common.
Athens	William C. Stehr, Ohio University	Athens	*E. vernalis*	Specimens were collected from a pool along R. R. tracks in Athens every year between 1932–1942. None was found there in 1943. On March 24, 1942, a collection was made from a pond on U. S. Route 50, two miles east of Athens, but in the spring of 1944 none was found there.
	H. T. Gier, Ohio University	Athens	*E. vernalis*	Specimens were collected in April of 1942 from a pond 1½ miles north of Athens.

species are *Eubranchipus vernalis* (Verrill). In all likelihood the specimens recorded in Table IV as "unknown" were *E. vernalis* inasmuch as it is the only common, widely distributed species in Ohio. The specimens from Delaware County listed by Burton and Hooker as Chirocephalus were probably misidentified as this genus has been recorded but once from North America (Creaser 1940), and collections from the same pool studied by them and from nearby pools during other years, so far as known, have been *E. vernalis*.

SUMMARY

The third and fourth seasons of an annual survey of fairy shrimp populations in Portage, Summit, and Stark Counties, Ohio, have yielded the following results:

1. Twenty-four pools out of sixty-one studied in 1943, and thirty-two out of sixty studied in 1944 contained *Eubranchipus vernalis*, the only species collected during those years.

2. The populations of *E. vernalis* varied considerably each season. Some pools formerly inhabited failed to contain fairy shrimps during a certain season, while some other pools which lacked them in former years developed large populations. Considerable fluctuation of abundance was found from year to year in some pools.

3. In the season of 1943 the fairy shrimps appeared early, and the eggs had probably hatched in the winter months of 1942. Most of the pools dried up early, however, and very few fairy shrimps could be collected after April 6.

4. The spring of 1944 was a very favorable one for *E. vernalis*, which was found in more pools and in greater abundance in most cases than during the preceding three years. In 1944 the spring pools did not fill with water until the first week of March. However, the fairy shrimps developed rapidly after that time and matured by the middle of April. Some populations continued until May 13.

5. A sample was collected and measured from pond P7 each week during both years from the time they were first observed until they disappeared from the pond. All data are presented in tabular form.

6. Evidence is presented to prove that males as well as females hatch from the "winter" eggs.

7. In many cases only a single generation is present during one season.

8. If dried-out pools are refilled in the spring before the onset of hot weather, another population may develop as was observed in pond P7 in the spring of 1943. If a pool does not fill up until late in the spring, it may develop a population which will develop rapidly as occurred in pond P88 in the late spring of 1944.

9. The sporadic distribution of fairy shrimps and the sudden annual changes which occur in many ponds, together with published experimental data on hatching, would indicate that the eggs of fairy shrimps are widely distributed over the ground, and they may or may not hatch any one year. Some of the eggs probably remain viable over a number of years before hatching. Thus, sudden changes of appearance and disappearance can best be explained.

10. *E. vernalis* has been found in temperature ranging between 0° and 21° C., and in hydrogen ion concentration ranging from pH 5.3 to 7.6.

11. The sex ratio of *E. vernalis* averages 1 male to 1.5 females.

12. Color changes have been observed in specimens maintained in the laboratory. The orange-pink or salmon colored immature forms change to light-green males and bluish-gray females. A population of light-blue individuals of both sexes was found in one pond in 1943. All specimens of this pond had the same unique coloring.

13. Recent records of fairy shrimps are reported from 24 of the 88 counties of Ohio.

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ERYTHRONEURA OF THE OBLIQUA GROUP FROM OHIO AND TENNESSEE

(Homoptera: Cicadellidae)

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An attempt is made to bring the work[1] on the obliqua group of *Erythroneura* up-to-date. Descriptions of five new species, new records for Ohio, corrections and synonymy are included.

Early in April, 1945, large numbers of *Erythroneura* were observed congregating on stones in swift-running streams, where they could be collected in numbers with an aspirator. Those taken in Delaware County, upon closer examination, proved to be almost exclusively members of the obliqua group, and males. Further collecting in this manner in Delaware and Hocking Counties showed that members of other *Erythroneura* groups had the same habit, but it seemed to be a characteristic of males only. A great variety of species occurred.

Unless other collectors are mentioned all specimens were taken by D. J. and J. N. Knull and are in collection of The Ohio State University or of author.

Erythroneura alata n. sp.

Figure 5

Ground color white, vittae bright red. Vertex with even-sided inverted U, rounded at apex, dusky area fills center; continued across pronotum as broad diverging vittae, space between them entirely dusky; scutellum dark, basal angles lighter in some specimens; elytra with broad claval vittae almost filling clavi, but for smoky area adjacent to scutellum, corial vitta broad, upper half appears to be joined to middle third of claval vitta by dark band of dorsum which shows through elytra; costal margin pellucid orange on basal part becoming broadly reddened toward crossveins; crossveins and adjacent part of longitudinal veins red, spots before crossveins and apical cells dusky, inner two cells translucent; small circular area around apices of clavi paler than rest of dorsum. Below a projection of vertexal U over apex of head, face dark, especially toward edges, legs pale, spines of hind femora dark, venter and dorsum chiefly dark.

Genitalia: Female, last ventral segment produced on middle third, pale. Male: Style with large foot, heel not projecting, base curved forming arc with inner margin of posterior point; anterior point narrow, projecting laterally, curved up; posterior point broad, three times as long and broad as anterior point and sharp-pointed. Aedeagus in lateral view short and heavy, ventral surface straight, dorsal sharply cut in before middle, and broadly swollen toward flattened tip, a pair of processes arises at ventral base of shaft, broadens into wing-like structures serrate on outer margins on apical half, narrowing to sharp, straight, spine-like apices.

Length: 3 mm.

Male holotype, Columbus, May 11, 1938; allotype, May 19, 1938; and paratypes, June 9, 1938; Delaware Co., April 2, 1945; April 26, 1944; April 30, 1944; August 27, 1942; Sept. 19, 1943; Oct. 3 and 10, 1943.

Near *E. funesta* Beamer in genital characters, but with a quite distinct color pattern. It bears somewhat the same relationship to *E. funesta* Beamer that *E. plena* Beamer does to *E. repleta* Johnson. In coloring it resembles *E. rufostigmosa* Beamer, but is darker.

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[1]D. M. Johnson, The Ohio Biological Survey Bulletin 31, issued July 8, 1935.

Erythroneura anomala n. sp.

Figure 9

Small, ground color creamy white with rather broad orange markings as follows: Vertex with inverted V broadly touching eyes, continuing across pronotum as two slightly diverging vittae; scutellum with tip orange, basal angles pellucid yellow; venter and dorsum yellow, abdominal segments and face more or less orange-tinged; a few black spines on hind femora. Elytra with orange oblique vittae, one on clavus, one on lower middle of corium, and one along costal margin; spots before crossveins and apices faintly dusky.

Inner male genitalia: Style with small rather square foot, heel very prominent, projecting down, its outer edge parallel with outer edge of toe, base curved, anterior point short, sharp, evenly joined to posterior point which is merely a small sharp projection. Aedeagus in lateral view broad, short and straight, with flattened dorsally projecting apex, and sides with pair of lateral broad projections straight out from middle, about as broad as shaft, bent down and narrowed toward apices.

Length: 2.5 mm.

Described from three males, holotype and paratype, Hocking Co., April 26, 1938; and Knox Co., May 8, 1933, D. M. Johnson, *Carpinus*.

A small member of the group, resembling *E. mansueta* Beamer somewhat in character of inner male genitalia.

E. autenae Johnson instead of *auteni*, as in original description. Additional specimens have been taken from Delaware Co.

E. caerula Beamer, from *Hypericum* sp., Scioto Co., June 10 and 17, 1944.

E. cauta Beamer, Delaware Co.

E. coarctata Beamer, Fig. 2, Hocking Co., April 17, 1938, and May 5.

E. cotidiana Beamer, Fig. 4, Hocking Co., April 12, 1945; Scioto Co., June 9, 1943, and June 17, 1944.

E. divisa McA. was reported for Ohio incorrectly as *E. atrimucronata* Beamer.

E. iconica McA., Fig. 7, Hocking Co., April 11, 1945.

E. idonea Beamer (Jour. Kans. Ent. Soc. 8: 100, 1935) has precedence over *E. gargantua* Johnson (Ohio Biol. Surv. Bull. 31: 81, 1935) by eight days since the date of issue of the Journal was July 1, and of the Bulletin July 8. This is a common species on buckeye in Delaware Co., and occurs in Adams and Scioto Cos.

E. infinita Beamer, Fig. 11, Pickaway Co., Feb. 20, 1935, J. S. Caldwell; Knox Co., Sept. 17, Mary Auten; Ashland Co., Mary Auten; Hocking Co., April 11, 1945.

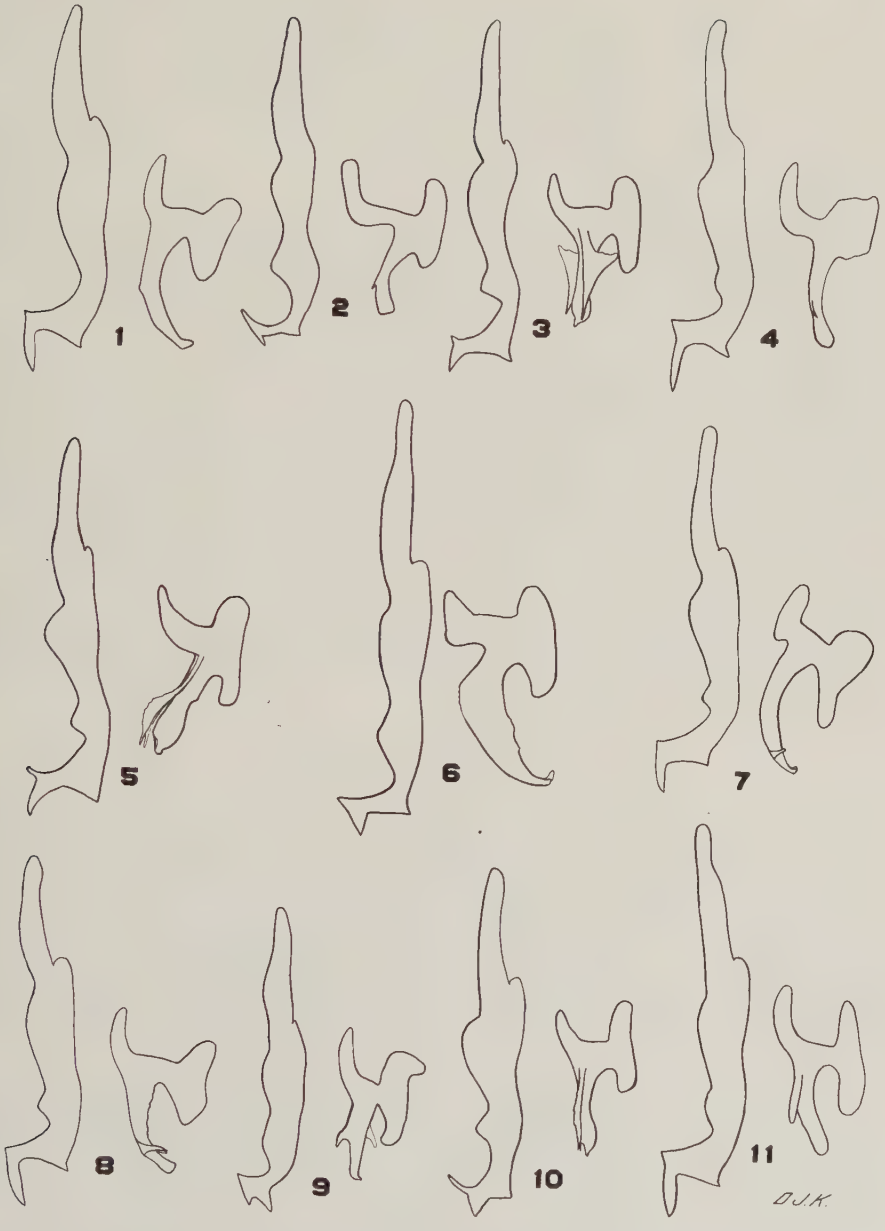
E. penelutea Beamer, Fig. 1, was reported from Ohio on the basis of one female specimen. A series has been taken throughout the season in Delaware and Hocking Cos.

E. perita Beamer, (Jour. Kans. Ent. Soc. 8: 100, 1935), Pickaway Co., April 5, 1934, J. S. Caldwell; Delaware Co., Aug. 27, 1942, Oct. 9, 1942, May 6, 1943, and Sept. 30, 1943. *E. extrema* Auten & Johnson (Ann. Ent. Soc. Am. 29: 64, 1936) is a synonym of this species.

Erythroneura praecisa n. sp.

Figure 10

General ground color white to semihyaline on elytra, where very little appears. Vertex with orange inverted V narrow at apex, and not touching eyes, even-sided, continued across pronotum as two slightly diverging orange vittae indented on outer margins at middle, and not touching anterior margin of pronotum; area between vittae darkened subcutaneously, basal angles of scutellum black, remainder yellow. Elytra extensively marked; clavus with broad vitta on basal two-thirds, dusky abdomen showing through gives outer third a dark cast, a narrow line along margin toward apex, usually lighter, a broad vitta on corium reaching crossveins, and a broad costal stripe, yellow translucent on plaque, crossveins partly red, dark spots above and below, except at base of M_2; R_1 and R_3 clouded, also base of M_2; lower part of M_4



FIGS. 1–11. Lateral view of style and aedeagus of *Erythroneura*. 1. *penelutea* Beamer. 2. *coarctata* Beamer. 3. *sagittata* Beamer. 4. *cotidiana* Beamer. 5. *alata* n. sp. 6. *victorialis* n. sp. 7. *iconica* McAtee. 8. *tenebrosa* n. sp. 9. *anomala* n. sp. 10. *praecisa* n. sp. 11. *infinita* Beamer.

and all of M_2 quite clear; below, head and legs sordid yellow, abdomen and mesonotum dark, dorsum dark.

Genitalia: Female, last ventral segment produced into truncate lobe on median third, pale, a few pale hairs on pygofer. Male: Style with small foot; heel a right angle, base short, straight, anterior point longer than posterior point and narrow, turned up, posterior point heavy, edges rough, as broad as base of foot, sides sharply converging, forming a little less than a right angle. Aedeagus almost straight in lateral view with rounded dorsal bulge toward flattened apex, a pair of narrow processes arises at anterior base and extends almost to tip, slightly serrate on ventral margin.

Length: 3 mm.

Holotype female, Hocking Co., June 1, 1938; allotype, April 28, 1934, J. S. Caldwell; paratypes August 31, 1944, and Sept. 16, 1943; paratypes, Great Smoky Mt. National Park, Tenn., June 14 and 21, 1942; and Indian Gap, Smoky Mts., Tenn., Sept. 8, 1939, Mary Auten.

In characters of genitalia close to *E. aspera* Beamer, but the foot of style is straight and aedeagus is narrower in lateral view.

E. sagittata Beamer, Fig. 3, Ashland Co., Sept. 23, Mary Auten; Delaware Co., Aug. 12, 1942, Sept. 9, 1943, Sept. 16, 1943, Oct. 3, 1943, and Oct. 9, 1942.

E. sincera Johnson has a pair of delicate processes just ventrad to base of shaft of aedeagus, sinuate, swollen slightly in middle, and extending to opening of duct. In this species as well as in *E. rubrotincta* Johnson, processes of aedeagus are often broken. Both species have been taken in Delaware Co., and *rubrotincta* has been taken also in Hocking, Monroe and Scioto Counties.

E. spearca Auten & Johnson, Hocking Co., April 17, 1938, and Oct. 17, 1941; Shawnee Forest, Scioto Co., June 9, 1943.

E. stolata McAtee, common in beech woods near Columbus. In some specimens a pair of fine lateral processes arises at base of aedeagus, separated from it, and extends almost parallel to shaft about one-third its length.

Erythroneura tenebrosa n. sp.

Figure 8

Ground color yellowish with narrow orange markings. Inverted V of vertex with a tendency toward clover-shape, two lateral prongs extend toward upper inner corner of eyes; vittae of pronotum, two dashes remote from margins; basal angles of scutellum yellow, narrowly outlined on inner margins with orange, apex orange, narrow oblique vitta on clavus, one on middle of corium and faint streak along costal margin, three dark rounded spots before crossveins and apical cells clouded, inner two clearer. The dark dorsum showing through elytra in region of middle of clavus gives a characteristic banded appearance. Below, face sordid yellow, legs pale, area below beak dark, segments of venter of abdomen sordid yellow, genital segments pale, a dark stripe at base of dorsum of abdomen and some darkening below surface of scutellum and middle of pronotum.

Inner male genitalia: Style with medium stout foot, heel moderately projecting, base slightly curved, posterior point as long as base of foot, heavy, sometimes very broad, slightly curved in, blunt; anterior point about a right angle. Aedeagus in lateral view, curved dorsad at tip, apex laterally broadened and blunt, dorsal surface roughened, a pair of spines arises on ventral surface just before shaft opening and extends laterad, these spines taper evenly to apices and in lateral view extend about one-third their length beyond shaft.

Length: 3 mm.

A common species. Male holotype, Delaware Co., April 30, 1944, and paratypes, allotype Sept. 19, 1943, and paratypes, March 18, 1945, Sept. 9, 1943, April 26, 1944, March 25, 1945, and April 2, 1945; Hocking Co., June 28, May 1, 1938, April 11, 1945; Columbus, May 16, 1937, Mary Auten; and specimens previously placed with *E. autenae* Johnson: Knox Co., May 8, 1933, M. Auten & D. M. Johnson; Richland Co., Oct. 16, 1934, M. Auten; Allen Co., Aug. 19, 1934, D. M. Johnson.

Very similar in characters of inner male genitalia to *E. tenuispica* Beamer from which it is readily separated by its dark dorsum.

E. torva Beamer, Mohican St. Park, July 31, 1935, D. M. Johnson; and Delaware Co., April 2, 1945.

Erythroneura victorialis n. sp.

Figure 6

Large, white with yellow markings except for those on clavus which are usually bright red. Head with broad indistinct inverted V not touching eyes, continued across pronotum as broad, faint, slightly diverging vittae; scutellum, basal angles and tip yellow; elytra, clavi with broad red vittae based on claval vein and filling a little more than apical third; outwardly and apically more translucent, shining, indistinct yellow with vittae on coria along vein and on costal margins, crossveins yellow, a few faint dusky spots before crossveins and apices hyaline. Below pale.

Genitalia: Female, last ventral segment produced sharply on median third, in lobe slightly indented over ovipositor, median lobe equal in length to sides, ovipositor entirely pale, a row of white spines either side on pygofer. Male: Style with large, long foot, heel sharp, projecting, base straight, anterior projecting laterad, slightly smaller than heavy posterior point with which it joins in even line on outer edge. Posterior point meets base at more than right angle and is sharp-pointed. Aedeagus large, in lateral view swollen just below base, curves caudad, narrowed on outer half, toothed on ventral surface on widest basal portion, and dorsally below middle; apex bifid.

Length: 3.5 mm.

Taken from blueberry at 5,000 to 6,000 ft. in Great Smoky Mt. National Park, Tenn., holotype male, allotype and paratypes June 14, 1942, and paratypes June 21, 1942.

A bright red V on the clavi when elytra are closed, noticeable with unaided eye, caused the preparator to call this the "victory leafhopper." It is near in genital characters to *E. nava* Beamer.

SEDIMENTARY ANALYSIS OF DRILL CUTTINGS FROM THE VANCE WELL, DELAWARE COUNTY, OHIO

WILLARD D. PYE[1]

The Chester L. Wise, et al, Herman E. Vance, No. 1, is located on Lot 11, Sec. 3, Orange Township, Delaware County, Ohio. This location is on the east side of the Olentangy River approximately 14 miles north of Columbus and 10 miles south of Delaware. Drilling commenced in September, 1934, and was completed in May, 1937, the entire hole being drilled by cable tool. The well started in the Ohio shale of Devonian age and bottomed at a total depth of 4291 feet in crystalline rocks of pre-Cambrian age. Despite the fact that the well was a dry hole, it is of importance because of the information it has yielded as to the subsurface stratigraphy of that part of Ohio. A detailed study of the drill cuttings from the Vance well has already been published.[2]

The total amount of material available for disaggregation and analysis was small, averaging only about 100 grams, and consisted of chips and sand brought up by the bailer from the indicated depths. Although some contamination of the cuttings undoubtedly occurred due to material being knocked off the upper walls of the hole during drilling operations, nevertheless, the analyses of the samples probably rather closely represent the formation being drilled.

The samples were taken at depths of 3435, 3440, and 3445 feet[3] and represent a Cambrian sandstone, possible just above the Jordan.[4] A gas-bearing brine was found at 3550 feet, just below the lowest sample.

The samples were all very uniform in appearance and consisted of a fine-grained, friable, fairly porous, yellowish-gray calcareous to dolomitic sandstone. The main cementing material was dolomitic calcite with some iron. In the coarse chips from the cuttings the carbonate is present as a cement binding the sand grains together; in the finer cuttings where the rock has been broken down into its individual mineral grain components, the carbonate cement is found as a fine powder. The original sand grains are rounded to well rounded and possess a fairly high degree of sphericity.

METHODS OF ANALYSIS AND DATA

Since it was obvious from microscopic examination that much of the "sand" was from the carbonate cement, one fraction of each sample was boiled for ten minutes in dilute hydrochloric acid to remove the carbonates, and in stannous chloride to clean the grains of iron oxide coatings so as to facilitate later mineral identification.

Table I gives the results of the mechanical analyses of both the untreated and acid treated samples. Sieving was by hand and lasted for 30 minutes. As this is longer than has recently become the standard practice for making sedimentary analyses, the final results probably were controlled to some extent by the largest opening in each sieve.

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[1]Now with the Texas Company, Box 167, U. S. A. C., Logan, Utah.

[2]W. Stout and C. A. Lamey, "Paleozoic and Pre-Cambrian Rocks of the Vance Well, Delaware County, Ohio," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 24, (1940), pp. 672–692.

[3]The samples were secured by Dr. G. D. Hubbard from Dr. W. Stout, State Geologist of Ohio. Acknowledgment is made to Messrs. A. J. Wallace and R. Mallory for supplemental information on the 3440 and 3445 foot samples.

[4]W. Stout and C. A. Lamey, *op. cit.*, pp. 672–692.

TABLE I

SIEVE ANALYSIS

DEPTH	3435 FEET	3440 FEET		3445 FEET	
Sieve Size (mm.)	Untreated %	Untreated %	Acid Treated %	Untreated %	Acid Treated %
1.000 – 0.495	trace	....	....	....	....
0.495 – 0.246	2.3	6.4	2.4	2.1	3.3
0.246 – 0.124	23.8	24.7	25.2	20.8	32.8
0.124 – 0.061	37.5	42.1	53.7	48.3	51.2
0.061 – Pan	36.4	26.8	18.7	28.8	12.7
Total	100.0	100.0	100.0	100.0	100.0
Mean Size	0.085	0.096	0.096	0.086	0.108
Standard Deviation	0.56	0.55	0.62	0.61	0.62
Per cent sample into solution by acid	64.1*	....	....	....	....
	62.2†	....	60.9	....	41.3

*Different sample than the one sieved.
†Sample used for chemical analysis of cements.

TABLE II

PIPETTE ANALYSIS OF SAMPLE FROM 3445 FOOT DEPTH
(Untreated by acid)

Size (mm.)	Per Cent	Per Cent of Total Size Distribution
1/16 – 1/32	40.9	11.8
1/32 – 1/64	40.9	11.8
1/64 – 1/128	11.7	3.4
Less than 1/128	6.5	1.8
Greater than 1/16 (from Table I)	....	71.2
Total	100.0	100.0

TABLE III

MINERALOGY OF SAMPLE FROM 3440 FOOT DEPTH

Minerals	Untreated Sample %	Acid Treated Sample %
Iron stained quartz	35	79
Opaques (Magnetite and Limonite)	5	10
Biotite	1	4
Muscovite	1	3
Garnet (pink and red)	1	3
Hornblende	1	1
Tourmaline	1	..
Opaque and semi-opaque iron carbonates	40	..
Calcite and Dolomite	15	..

The material from the non-acid treated sample caught on the pan during the sieving of the 3445 foot depth sample was boiled in a solution carrying 0.5 grams of sodium carbonate and then diluted to 1000 cc. for pipette analysis. The results are presented in Table II. How much of this distribution was due to carbonate cement fragments was not determined.

The mineralogy of the samples is given below and is based upon both heavy mineral and thin section analyses.

Sample from 3435 foot depth: The cement binding the sand grains together consists of carbonate with minor amounts of iron oxide. Some post-depositional pyrite is also present. No silica cement is evident. Magnetite makes up fully fifty per cent of the heavy minerals; pyrite, limonite, and leucoxene make up minor amounts. The non-opaque heavy minerals are freshly broken (during drilling?) pink garnet, rounded topaz grains with many inclusions, and well rounded olive-green zircons. The dominant detrital light mineral is quartz, which may be clear or filled with inclusions. Acid feldspar is present but not common. The very abundant carbonate cement is all recrystallized and shows no evidence of a detrital origin.

Sample from 3440 foot depth: See Table III.

Sample from 3445 foot depth: Iron-stained quartz makes up most of the detrital minerals. Zircons, garnet, flourite, hematite, magnetite, leucoxene, and pyrite are present in small amounts. Magnetite makes up over 40 per cent of the heavy minerals with the other ore minerals making up most of the rest. Fragments of well crystallized carbonate cement are very common in the light fraction.

Chemical Analysis of Sample from 3435 Foot Depth: After a sample from the 3435 foot depth was leached with hydrochloric acid, it was found that a total of 62 per cent had gone into solution. This solution was analyzed for calcium, magnesium, and iron percentages. Although undoubtedly other elements for which no tests were made were present in minor amounts, the following were calculated to have made up all of the material that was dissolved by the acid:

$CaCO_3$ 57%
$MgCO_3$ 23%
$FeCO_3$ and Fe_2O_3 ..... 20%

(Note: Some of the iron probably came from small amounts of the magnetite and other iron minerals going into solution during the acid treatment.)

CONCLUSIONS

The formation is a highly dolomitic, calcareous, fine-grained sandstone with considerable iron carbonate and oxide. Silica cement is nil. The insoluble portion is dominantly made up of fine quartz sand with very little feldspar. Small amounts of heavy minerals are present. Of these, magnetite and the other opaque ore minerals predominate.

The degree of sorting coupled with the presence of well rounded zircon and topaz grains would indicate probably at least a second cycle of erosion for some of the sand. Not enough evidence was available to determine whether the sand was (1) deposited under aeolian conditions with later carbonate cementation by ground water, or (2) deposited under near shore, clear water conditions with no major streams entering the sea in the general vicinity, and a low lying, probably peneplaned, land-mass making up the coastal area. Either case would give a clean, well sorted, medium fine, calcareous sandstone deposit. The latter probably represents the conditions of deposition unless the formation is a combination of the two, being an aeolian sand reworked and deposited under the above outlined marine conditions.